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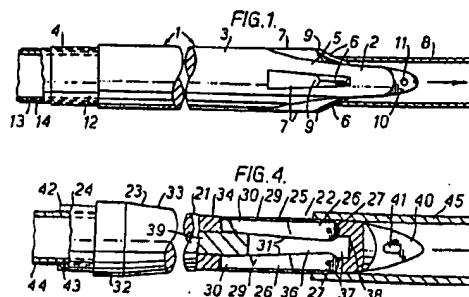
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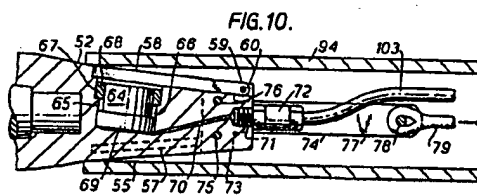
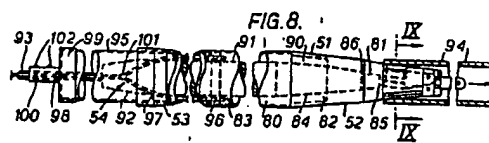
64 Mains insertion.

57 The present invention relates to the replacement of an existing main, particularly an existing cast iron gas main, with a new main utilising a device in the form of a mole. The mole 1, which is of steel, is adapted to be inserted into and moved along the existing main 8. The mole 1 has a front portion comprising a head 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main 13. The head 2 has a cutting face 5 for engaging the internal wall of the existing main 8 so as to cause the wall to fracture as the mole 1 moves therealong. The new main 13 which in use is clamped to the mole 1 is towed along behind the mole 1 to replace the fractured old main 8. In one embodiment of the invention (Figure 1) the cutting face 5 comprises three or more cutting edges 6 formed by grinding on high tensile steel cutters 7 which are located in keyways in the head 2. In another embodiment of the invention (Figure 4) the cutting face 25 may comprise three or more pivotally mounted cutting blades 26 which are pivotally mounted at their forward ends 27 to the wall of the head 23. The blades 26 are caused to pivot radially outwardly from their closed position to engage the pipe wall 45 and fracture it as the mole moves along the pipe towing the new main 43 therewith.

In still another embodiment of the invention (Figure 10) only one 58 of the blades is pivotally mounted at its forward end 59 to the mole 51, the other blades 56, 57 being fixed. In

this embodiment, the mole 51 is driven through the existing main 94 by means of a pneumatically actuated hammer 80 (Figure 8) engaging percussively with an internal wall of the mole formed by an internal bore 82. The pivotal blade 58 pivots under the action of an associated piston 64 which is hydraulically actuated by fluid supplied from a hose 103 by way of a channel 70. The blade 58 is normally closed but is pivoted to fracture any circumferentially located obstruction located in the main 94 and serving to inhibit the movement of the mole 51 therethrough.





The present invention relates to the replacement or the preparation for replacement of an existing main, particularly an existing cast iron gas main, with a new main and is particularly concerned with a method and a device for enabling this replacement to be carried out.

Mains have to be replaced for a number of reasons, for instance, the existing main may be in poor condition or the existing main may not be of sufficient capacity to accommodate a modified load.

The usual means of replacing a gas main involves the use of costly and labour intensive total excavation of the surrounding ground. Alternatively, if total excavation is avoided and the new main is merely inserted into the existing main, it will, by necessity, be of smaller internal diameter than the existing main and thus will be of smaller gas carrying capacity.

It is an object of the present invention to enable an existing main to be replaced or prepared for replacement by a new main without any of the above disadvantages.

According to one aspect of the present invention, there is provided a method for replacing or preparing for replacement an existing main with a new main, the method comprising fracturing the existing main and maintaining

sufficient clearance through the fractured main for movement therethrough of a new main or a liner for the fractured main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a side view of a first embodiment of the mole shown in use,

Figure 2 is an end view of the mole cutting face shown in Figure 1 and having four cutting edges,

Figure 3 is an end view of the mole cutting face shown in Figure 1 and having three cutting edges,

Figure 4 is a side view partly in section of a second embodiment of the mole shown at the commencement of operation,

Figure 5 is a view of the mole shown in Figure 4 during operation,

Figure 6 is an end view of the mole cutting face shown in Figures 4 and 5 and having three cutters shown in hidden detail and

Figure 7 is an end view of the mole cutting face shown in Figures 4 and 5 having four cutters shown in hidden detail.

Figure 8 is a side view of a third embodiment of the mole shown in use and broken away in part to reveal internal detail,

Figure 9 is a view along the lines IX-IX of Figure 8 and

Figure 10 is a close up view of the front of the mole partly in section.

Referring to the Figures 1 to 3, Figure 1 shows a steel mole 1 having a front portion consisting of a head portion 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main.

The head portion 2 has a cutting face 5 comprising three or more cutting edges 6 formed by grinding high tensile steel cutters 7 (four cutters are shown in Figures 1 and 2). The cutters 7 are housed in keyways (not shown) in the head portion 2, which is in the form of a cylinder tapering towards the front end of the mole, the cutters 7 being attached to the head portion 2 by means of bolts (not shown) so that the cutters 7 are removable from the head portion 2. The cutting face 5 tapers radially inwardly in the direction of the forward end of the mole 1, that is, the

radii of the cutting edges 6 decrease towards the forward end of the mole 1 so as to enable the cutting face 5 to exert a continuously increasing cutting action on the existing main 8 as the mole 1 moves therethrough.

The cutting face 5 terminates at rearward points 9 on the head portion 2, which points 9 are concentrically aligned with the periphery of the body portion 3 and the keyways are arranged on the head portion 2 so that the cutters 7 and their cutting edges 6 in position on the mole 1 lie in an axial plane of the mole 1.

The front end of the head portion 2 is provided with a housing 10 cast into the head portion 2 and provided with an eye 11 to enable the mole 1 to be connected to a steel winch cable (not shown).

The rear portion of the mole 1 is provided with a clamping means 4 in the form of a sleeve 12 secured to the body portion 3 and being of slightly smaller external diameter than that of the body portion 3. The sleeve 12, in use, receives the end of the new main 13 which is of a flexible material such as plastics. The end of the new main 13 is first surrounded by a protective plastics sleeve 14 and the main 13 and sleeve 14 are pushed into the clamping sleeve 12. This is arranged to have an internal diameter approximately equal to the external diameter of the new main 13 so that this fits securely within and is tightly gripped

and clamped by the clamping sleeve 12.

The cutters 7 are arranged to be spaced equiangularly around the axis of the cutting face 5 as shown in Figures 2 and 3 and the taper of the cutting face 5 prevents the mole 1 from twisting and turning on its horizontal axis thereby preventing undue strain on the new main and associated pneumatic feedlines (not shown).

In use, the ground at either end of the existing cast iron main 8 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 8 from one end and is secured to the shackle housing 10 via the eye 11. The new plastic main 13 and its sheath 14 are then clamped to the clamping sleeve 12. The new plastics main 13 can be of the same or slightly larger internal diameter than the existing cast iron main 8. The head portion 2 of the mole 1 is then inserted into the existing cast iron main 8 until the cutting edges 6 engage the end of the main 8 as shown in Figure 1.

The cable is then wound onto the winch so as to pull the mole 1 through the existing main 8. At the same time the rear portion 12 is acted upon by a pneumatic hammer (not shown) to drive the mole 1 into the main 8. The combined tension and pneumatic pressure cause the mole 1 to move along the main 8 so that the cutting edges 7 engage the internal wall of the main 8 and cause the wall to fracture

due to their intense localised pressure on the wall as the mole 1 moves therethrough. The cylindrical body 3 widens out the internal diameter of the fractured main 8 since, in use, the body 3 is selected to have a diameter greater than that of the original internal diameter of the main 8. The body 3 also prevents debris from the fractured main and earth from falling into the pathway created for the new main. As the mole 1 proceeds along the new fractured main 8 it tows the new main 13 and its associated sheath 14 with it, the internal diameter of the new main 13 being equal to or slightly larger than that of the existing main 8. When the new main 13 is finally in position, the new main 13 and its sheath 14 are removed from the clamping sleeve 12.

As a general rule the outer diameter of the body portion 3 of the mole 1 is arranged to be about 1/8" greater than the outer diameter of the existing main and the outer diameter of the clamping sleeve 12 is about 1/8" less in diameter than that of the cylindrical body portion 3 of the mole 1.

Referring to Figures 4 to 7, Figure 4 shows a steel mole 21 having a front portion consisting of a head portion 22 and a body portion 23 and a rear portion having a clamping means 24 for clamping a new main.

The head portion 22 has a cutting face 25 comprising

three or more pivotally mounted cutting blades 26 (four are present on the mole shown in Figures 4 and 5). The blades 26 are disposed in elongated axially directed slots (not shown) in the wall of the head portion 23 and are pivotally mounted at their forward ends 27 to the wall of the head portion 23.

Referring to Figures 6 and 7 the blades 26 are arranged to be spaced equiangularly around the axis of the cutting face. Each blade 26 has a cutting edge 28 formed by two sloping sides 29, two parallel sides 30 adjoining the sloping sides 29 and a concave side 31 distal from the cutting edge 28 between the parallel sides 30.

Referring to Figures 4 and 5 the concave side 31 slopes away from the cutting edge 28 in a direction forwardly of the mole 1.

The body portion 23 has a cylindrical rear portion 32, a frustoconical portion 33 tapering forwardly of the mole and a cylindrical front portion 34 adjoining the slot forming walls (not shown) of the head portion 23.

The body portion 23 is provided with a circular centrally located through-going bore 35 (see Figure 5) which merges with a passageway 36 formed by the concave sides 31 of the blades 26 and the internal concave shaped walls (not shown) of the head portion slot forming walls. The

passageway 36 merges with a circular centrally located through-going bore 37 located near the forward end of the head portion 23 beyond the pivotted ends 27 of the blades 26. The bore 27 is provided with a conical termination 38.

The bore 35 and passageway 36 house an hydraulically operated cylindrical ram 39 which is capable of movement within the bore 35 and passageway 36. The front of the ram 39 is engaged at all times with the concave sides 31 of the blades 26. When the blades 26 are in the closed position shown in Figure 4 the cutting edges 28 are axially aligned with the front portion 34 of the body portion 23. The concave sides 31 of the blades 26 extend further radially into the passageway 36 than do the internal concave shaped walls of the head portion slot forming walls (not shown) so as to permit the blades 26 to pivot outwardly from the closed position in Figure 4 to the open position in Figure 5 as the ram 39 is moved forwardly along the passageway 36 and encounters the radially inward slope of the concave sides 31.

The front end of the head portion 22 is provided with a housing 40 and an eye 41 similar to that shown in the mole of Figure 1 and for similar purposes.

The rear portion of mole 21 is provided with a clamping means 24 in the form of a clamping sleeve 42

similar to that shown in the mole in Figure 1. As in that mole, the clamping sleeve 42 is secured to the body portion 23 and is of slightly smaller diameter than the rear portion 32 of the body portion 23. The new plastics main 43 and its protective sheath 44 are secured and clamped to the clamping sleeve 42 in exactly the same manner as previously described for the mole shown in Figure 1.

In use, as with the mole described in Figure 1, the ground at either end of the existing cast iron main 45 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 45 from one end and is secured to the housing 40 via the eye 41. The new plastics main 43 and its sheath 4 are then clamped to the clamping sleeve 42. The new plastics main 43 can be of the same or slightly larger internal diameter than the existing cast iron main 45. The head portion 22 of the mole 21 is then inserted into the existing main 45 until a portion at least of the cutting blades 26 lie adjacent to the internal wall of the existing main 45 as shown in Figure 4. The ram 39 is actuated hydraulically to move forwardly within the passageway 36 to cause the blades 26 to pivot about their ends 27 to engage and fracture the cast iron main 45 by the intense localised pressure of their cutting edges 28 upon the internal wall of the main 45 as shown in Figure 5. After a portion of the main 45 has been cracked open the ram 39 is withdrawn to the position shown in Figure 4 so that the blades 26 return to the closed position of Figure 4.

The winch cable (not shown) is then wound onto the winch so as to pull the mole 21 through the existing main 45 by an amount not exceeding the length of the blades 26. A next portion of the existing main 45 is then fractured by the method just described and the mole 21 is then pulled through the main 45 by a further amount not exceeding the length of blades 26. This process is repeated until the entire length of the existing main 45 has been fractured. As the mole 21 moves through the fractured main 45 the body portion 23 widens out the internal diameter of the fractured main 45 since, in use, the rear portion 32 of the body portion 23 is selected to have a diameter greater than that of the original internal diameter of the cast iron main 45.

The body portion 23 also prevents debris from the fractured main 45 and earth from falling into the pathway created for the new main 43. As the mole 21 proceeds along the fractured main 45, it tows the new main 43 with it the internal diameter of the new main 43 being the same or slightly larger than that of the existing main 45. When the new main 43 is finally in position, the new main 43 and its sheath 44 are removed from the clamping sleeve 42.

Referring to Figure 8, the steel mole 51 comprises a front portion consisting of a head 52 tapering generally conically towards its front end and a cylindrical rear portion 53 incorporating clamping means 54 for clamping a

cylindrical liner for the new main.

As shown more clearly in Figures 9 and 10 the head portion 52 has a cutting face 55 comprising three blades 56, 57 and 58 disposed in elongated axially directed slots in the wall of the head 52. Two lower blades 56 and 57 (shown in Figure 9) are attached rigidly in the slots so that they are fixed.

The other upper blade 58, which is wider and thicker than the lower blades, is pivotally mounted at its forward end 59 to the wall of the head portion 52.

The upper blade 58 pivots on a pin 60 extending through portions (not shown) of the head 52 of the mole 51, the portions forming a recess (not shown) to accommodate movement of the blade 58.

As shown in Figure 9, the blades 56 to 58 are spaced equiangularly around the axis of the cutting face which tapers forwardly to the front end of the mole 51. Each blade 56 to 58 has a cutting edge 60 formed by two sloping sides 61 and a base 62 distal from the cutting edge 60 and formed between parallel sides 63.

Referring to Figures 9 to 10 the head 52 of the mole 51 houses an hydraulically actuated piston 64 slidable within a cylindrical bore 65 within the head 52. The bore

65 has a portion in which the piston 64 is slidable. An internally threaded cylindrical recess 67 is located above the portion 66 and receives an externally threaded stop ring 68. The stop ring 68 serves to limit the extent of upward movement of the piston 64 when it engages with a lowermost stop collar 69 forming an integral part of the piston 64.

As shown in Figures 8 and 10 the head 52 is provided with a hydraulic fluid channel 70 which at one end communicates with the bore 65 below the piston 64 and terminates in a threaded bore 71 of wider diameter at the front end of the head 52. The threaded bore 71 serves to receive the threaded connector of a hydraulic hose coupling 72.

While not shown, the front end of head 52 is recessed laterally on two sides to receive and engage the cross-pieces 73 of two adjacent T-shaped winch cable connecting plates 74 (only one plate 74 shown in the drawings). The plates 74 are connected to each other and to the front end of the head 52 by a pair of connecting pins 75 and 76 which extend through the cross-pieces 73 of the plates 74 via the front end of the head portion 52. The uprights 77 of the connecting plates 74 extend forwardly of the mole 51 and are connected together by a pin 78 which also forms a connecting point for the cable 79 of a winch (not shown).

Referring to Figure 8, the rear 53 of the mole 51 comprises a generally hollow cylinder adjoining the conically tapering molehead 52. The mole 51 forms a housing for a pneumatically actuated hammer device 80.

The hammer 80 has head portion 81 projecting into an internal bore 82 formed in the head 52 of the mole 51, the rear 83 of the hammer 80 being axially disposed with clearance in the cylindrical rear portion 53 of the mole 51.

The head portion 81 of the hammer 80 comprises a forwardly conically tapering portion 84 terminating in a cylindrical end 85. The diameter of the end 85 is less than the diameter of the adjoining end of the conically tapering portion 84 so that there is an annular shoulder 86 formed between the portion 84 and the hammer end 85.

As shown in Figure 8 the portion 84 and the end 85 of the hammer head 81 are, in use, able to cooperatively engage in corresponding portions of the internal bore 82, these portions also forming an annular shoulder for cooperation with the annular shoulder 86 in the hammer head 81. A rear part of the hammer portion 84 is disposed axially with clearance in a wider forwardly conically tapering portion 90 of the internal bore 82, the portion 84 terminating within the rear 53 of the mole 51.

The rear 83 of the hammer 80 comprises a cylindrical

portion 91 terminating in a rearwardly tapering conical portion 92 which is provided with a coupling (not shown) for an air hose 93.

In use, compressed air supplied to the hammer 80 through the hose 93 causes the hammer 80 to reciprocate in the conventional manner to drive the mole 51 through the existing main 94 by the percussive action of the hammer head 81 upon the corresponding cooperating portions of the internal bore 8 of the mole 51.

The means 54 for clamping the liner 95 to the mole 51 comprises a steel ring 96 for engaging the rear end of the liner 95, a looped cable 97 connected the ring 96, a tensioning cable 98 connected to the cable 97, a clamping cup 99 for engaging the far end of the liner 95 and a tensioning device 100 for tensioning the cable 98.

The steel ring 96 is secured as by welding within and to the internal wall of the rear portion 53 of the mole 51. The ring 96 is formed with holes (not shown) to enable the ends of the looped steel cable 97 to be secured thereto.

The clamping cup 99 which is also of steel is adapted to receive and locate the far end of the liner 95 and is apertured (not shown) for the passage therethrough of the air hose 93 and of the tensioning cable 98.

The tensioning cable 98 which is also of steel, is coupled by a conventional hitch 101 at one end to the looped cable 97 and is connected via its other end to the tensioning device 10. Tensioning device 100 comprises a ratchet winch arrangement 102.

In use of the mole 51, as with the moles previously described the ground at either end of the existing cast iron main 94 is excavated to expose the ends of the main 94. The steel cable 79 of a motorised winch is then fed through the main 94 from one end and is secured to mole 51 located at the other end of the main 94. The cable 79 is connected to the winch cable plates 74 by way of the winch cable pin 78. Next the hydraulic hose 94 is fed through the same end of the main 94 as the cable 79 and is coupled to the fluid bore 71 in the mole head 52 by way of the hose coupling 72.

In the next stage, the liner 95 is clamped to the mole 51. Initially, the looped cable 97 is secured to the ring 96 and the cable 97 is then secured to the tensioning cable 98. The liner 95 is then pushed up the cylindrical portion 53 of the mole 51 until one end of the liner 95 engages with the ring 96. The clamping cup 99 is then slid along the tensioning cable 98 and the air hose 93 until the other end of the liner 95 is located within and engages with the cup 99. The tensioning cable 98 is then tensioned by the tensioning device 100 and the liner 95 is therefore clamped

CLAIMS

1. A method for replacing or preparing for replacement an existing main with a new main, characterised in that the method comprises fracturing the existing main (8,45,94) and maintaining sufficient clearance through the fractured main (8,45,94) for movement therethrough of a new main (13,43) or a liner (14,44,95) for the fractured main (8,45,94) the liner (14,44,95) to serve as a protective sleeve for the new main (13,43) when the new main is subsequently moved into the liner (95).

2. A method as claimed in Claim 1, characterised in that the new main (13,43) is presleeved with the liner (14,44) before the new main (13,43) is moved through the fractured main (8,45,94).

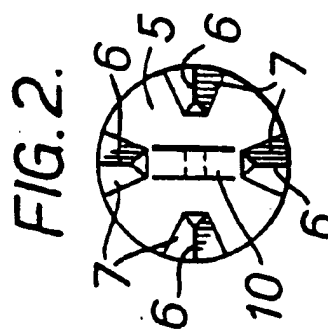
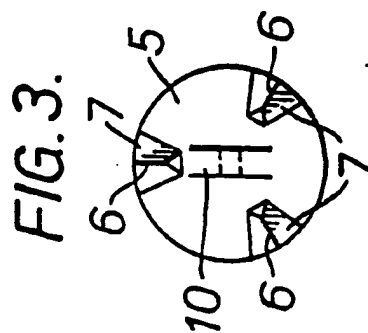
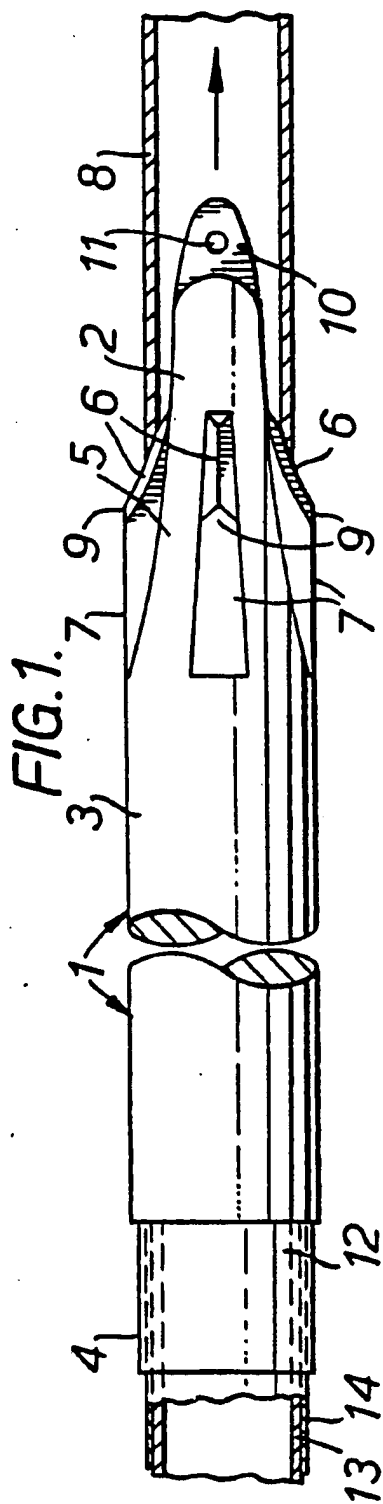
3. A method as claimed in Claim 1 or Claim 2, characterised in that the existing main (8,45,94) is continuously fractured ahead of the moving new main (13,43) or liner (14,44,95).

4. A method as claimed in any of Claims 1 to 3, characterised in that the internal diameter of the new main (13,43) is equal to or greater than the internal diameter of the existing main (8,45,94).

5. A method as claimed in any of Claims 1 to 4, characterised in that the clearance provides a bore whose diameter is greater than the external diameter of the existing main (8,45,94).

6. A method as claimed in any of the preceding claims in which the clearance provides a bore whose diameter is greater than the external diameter of the new main (13,43) or the liner (14,44,95).

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FIG. 4.

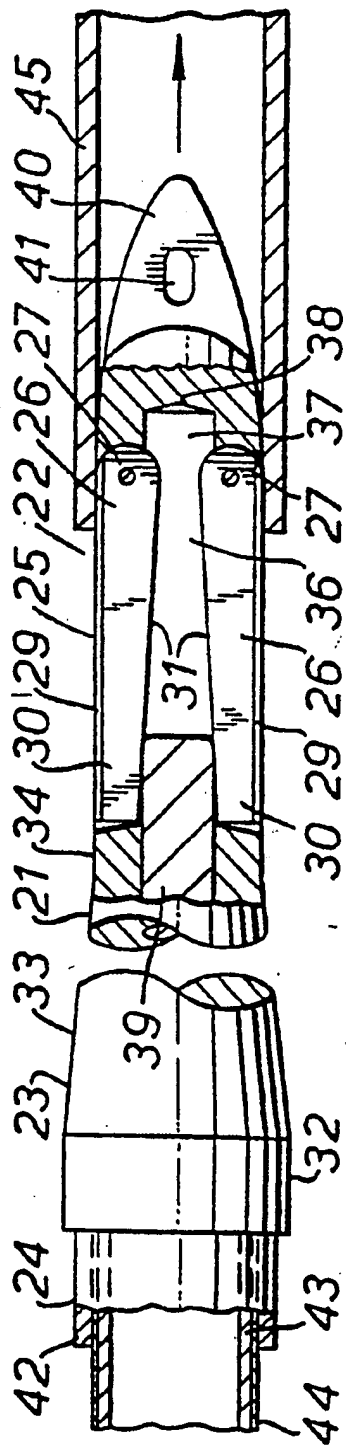
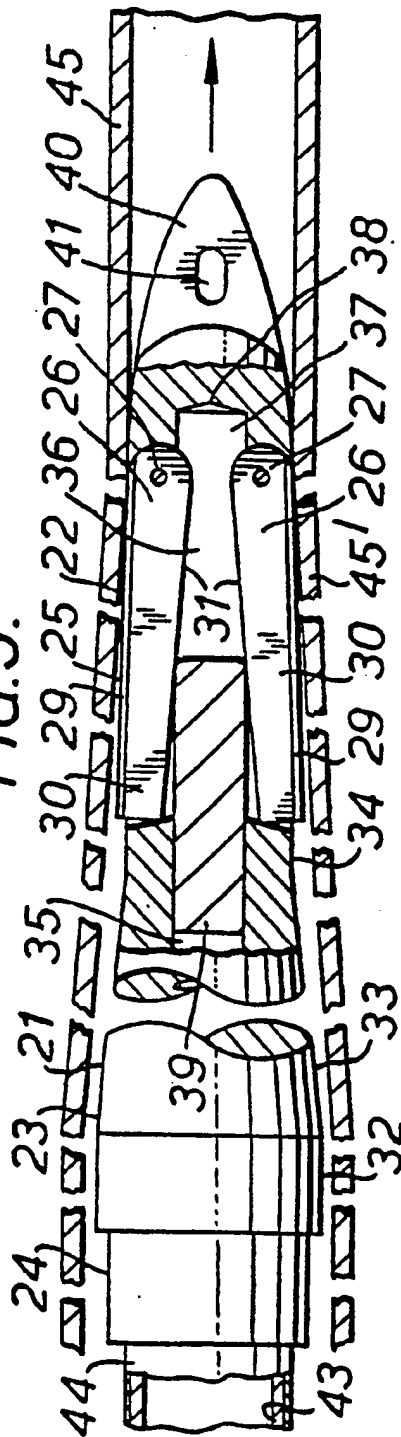


FIG. 5.



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FIG. 6.

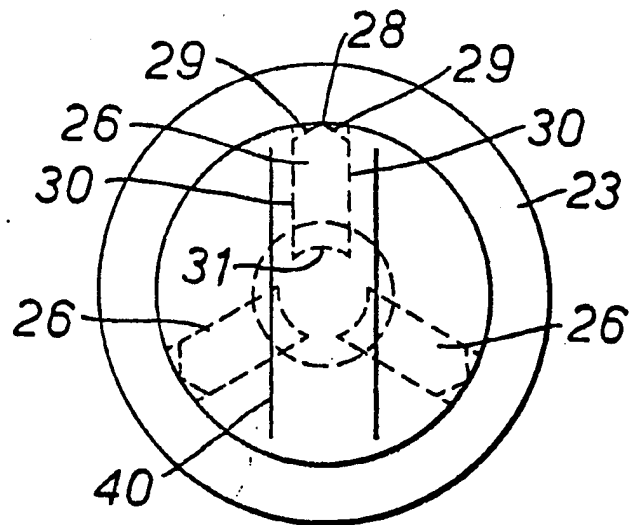
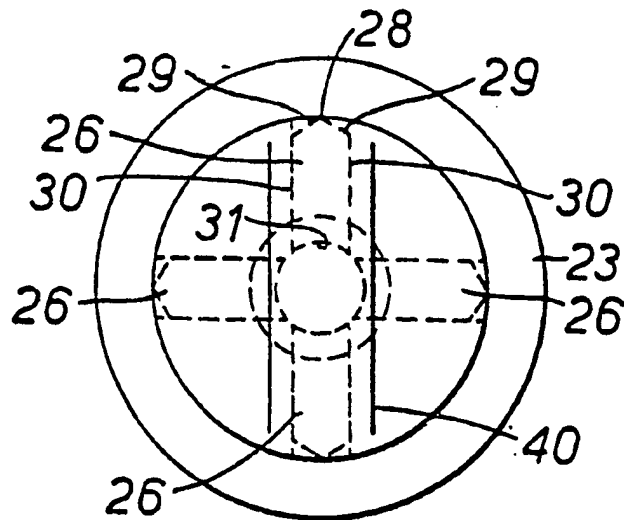
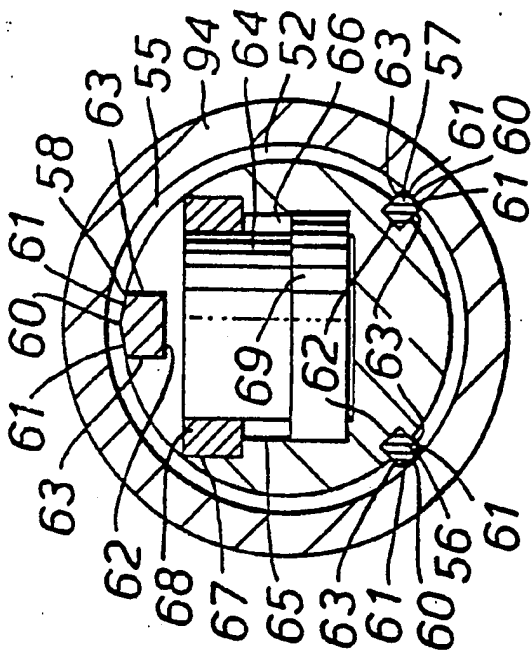
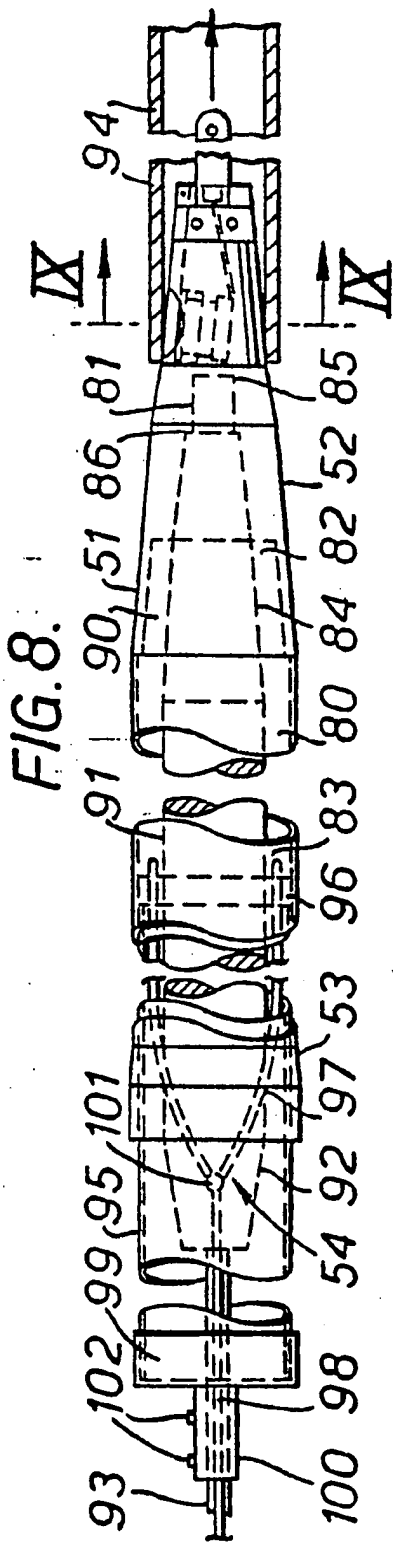


FIG. 7.

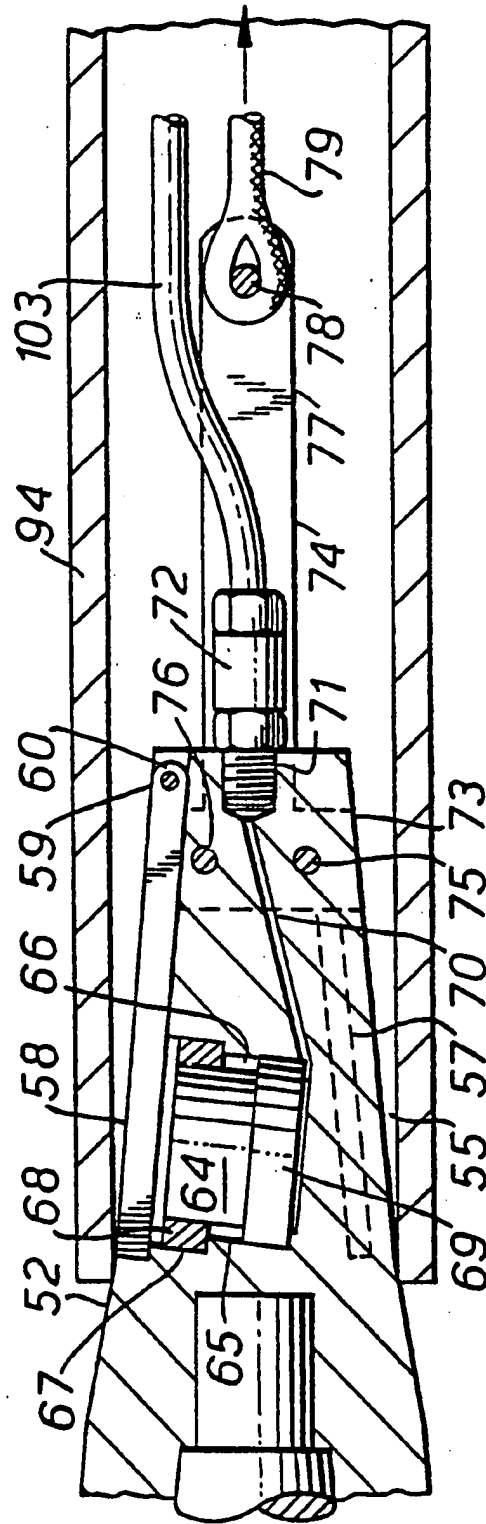


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FIG. 10.



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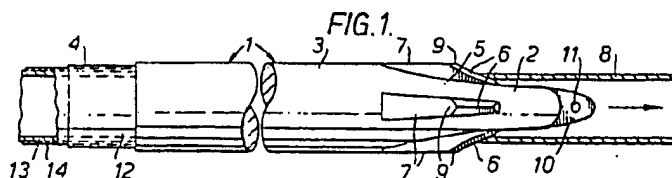
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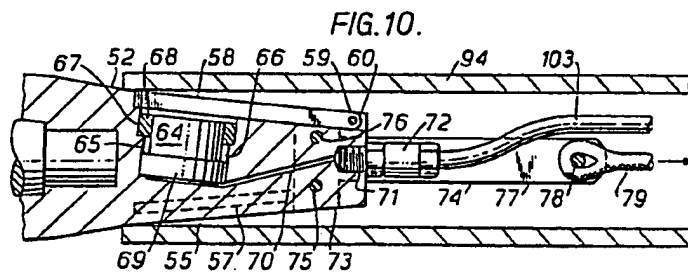
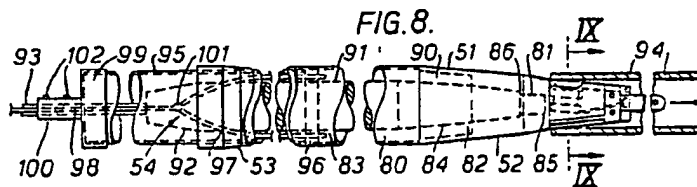
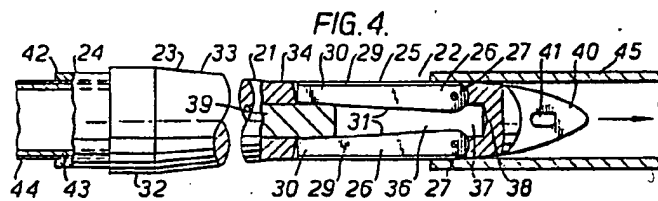
54 Mains insertion.

57 The present invention relates to the replacement of an existing main, particularly an existing cast iron gas main, with a new main utilising a device in the form of a mole. The mole 1, which is of steel, is adapted to be inserted into and moved along the existing main 8. The mole 1 has a front portion comprising a head 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main 13. The head 2 has a cutting face 5 for engaging the internal wall of the existing main 8 so as to cause the wall to fracture as the mole 1 moves therealong. The new main 13 which in use is clamped to the mole 1 is towed along behind the mole 1 to replace the fractured old main 8. In one embodiment of the invention (Figure 1) the cutting face 5 comprises three or more cutting edges 6 formed by grinding on high tensile steel cutters 7 which are located in keyways in the head 2. In another embodiment of the invention (Figure 4) the cutting face 25 may comprise three or more pivotally mounted cutting blades 26 which are pivotally mounted at

their forward ends 27 to the wall of the head 23. The blades 26 are caused to pivot radially outwardly from their closed position to engage the pipe wall 45 and fracture it as the mole moves along the pipe towing the new main 43 therewith.

In still another embodiment of the invention, (Figure 10) only one 58 of the blades is pivotally mounted at its forward end 59 to the mole 51, the other blades 56, 57 being fixed. In this embodiment, the mole 51 is driven through the existing main 94 by means of a pneumatically actuated hammer 80 (Figure 8) engaging percussively with an internal wall of the mole formed by an internal bore 82. The pivotal blade 58 pivots under the action of an associated piston 64 which is hydraulically actuated by fluid supplied from a hose 103 by way of a channel 70. The blade 58 is normally closed but is pivoted to fracture any circumferentially located obstruction located in the main 94 and serving to inhibit the movement of the mole 51 therethrough.







European Patent
Office

EUROPEAN SEARCH REPORT

0094694

Application number

EP 83 10 5111

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
A	FR-A-2 279 009 (TIDRIL CORPORATION) * Page 2, lines 16-29; page 6, lines 13-30; figures 3-5 *	1,3-6	F 16 L 55/16
A	FR-A-2 318 370 (TIDRIL CORPORATION) * Claim 1 *	1,3-6	
A	GB-A-1 261 952 (RAYMOND MUIR BREMNER) * Page 1, lines 29-40 *	1	
A	GB-A- 263 436 (MATHIAS BOCK) * Claim 1 *	1	
A	US-A-3 511 734 (A. DARROW) -----	2	TECHNICAL FIELDS SEARCHED (Int. Cl. 7) F 16 L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29-03-1984	Examiner ANGIUS P.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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Description

The present invention relates to the replacement or the preparation for replacement of an existing main, particularly an existing cast iron gas main, with a new main and is particularly concerned with a device for enabling this replacement to be carried out.

This application is divided out from the copending European Patent 0053480 which is directed to a device for replacing an existing main.

Mains have to be replaced for a number of reasons, for instance, the existing main may be in poor condition or the existing main may not be of sufficient capacity to accommodate a modified load.

The usual means of replacing a gas main involves the use of costly and labour intensive total excavation of the surrounding ground. Alternatively, if total excavation is avoided and the new main is merely inserted into the existing main, it will, by necessity, be of smaller internal diameter than the existing main and thus will be of smaller gas carrying capacity.

US Patent Specification No. 3181302 is directed to an apparatus for replacing a pipe occupying an underground passageway through which a substantially horizontal axis extends. The apparatus comprises a pipe splitting cutter in which is adapted to be drawn through the pipe so as to progressively slit the pipe into two longitudinal halves. These are then spread apart by a spreader to enable a new pipe which is previously coupled to the apparatus to occupy the position of the existing pipe.

It is an object of the present invention to enable an existing main to be replaced or prepared for replacement by a new main.

According to the present invention, there is provided a method for replacing or preparing for replacement a buried existing main with a new main, the method comprising dividing the buried main in situ to form discrete portions and moving the portions radially outwardly to widen the bore of the main to form a passage having a diameter at least as great as the external diameter of the new main or a liner for the existing main, maintaining sufficient clearance through the passage for movement therethrough of a new main or a liner for the existing main and moving the new main or liner endwise into the passage simultaneously with the widening of the bore of the buried existing main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner, characterised in causing at least a portion of the radially outward movement of the divided portions to occur simultaneously with the formation of the portions.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a side view of a first embodiment of the mole shown in use,

Figure 2 is an end view of the mole cutting face shown in Figure 1 and having four cutting edges,

Figure 3 is an end view of the mole cutting face shown in Figure 1 and having three cutting edges,

Figure 4 is a side view partly in section of a second embodiment of the mole shown at the commencement of operation,

Figure 5 is a view of the mole shown in Figure 4 during operation,

Figure 6 is an end view of the mole cutting face shown in Figures 4 and 5 and having three cutters shown in hidden detail,

Figure 7 is an end view of the mole cutting face shown in Figures 4 and 5 and having four cutters shown in hidden detail,

Figure 8 is a side view of a third embodiment of the mole shown in use and broken away in part to reveal internal detail,

Figure 9 is a view along the lines IX-IX of Figure 8, and

Figure 10 is a close up view of the front of the mole partly in section.

Referring to the Figures 1 to 3, Figure 1 shows a steel mole 1 having a front portion consisting of a head portion 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main.

The head portion 2 has a cutting face 5 comprising three or more cutting edges 6 formed by grinding high tensile steel cutters 7 (four cutters are shown in Figures 1 and 2). The cutters 7 are housed in keyways (not shown) in the head portion 2, which is in the form of a cylinder tapering towards the front end of the mole, the cutters 7 being attached to the head portion 2 by means of bolts (not shown) so that the cutters 7 are removable from the head portion 2. The cutting face 5 tapers radially inwardly in the direction of the forward end of the mole 1, that is, the radii of the cutting edges 6 decrease towards the forward end of the mole 1 so as to enable the cutting face 5 to exert a continuously increasing cutting action on the existing main 8 as the mole 1 moves therethrough.

The cutting face 5 terminates at rearward points 9 on the head portion 2, which points 9 are concentrically aligned with the periphery of the body portion 3 and the keyways are arranged on the head portion 2 so that the cutters 7 and their cutting edges 6 in position on the mole 1 lie in an axial plane of the mole 1.

The front end of the head portion 2 is provided with a housing 10 cast into the head portion 2 and provided with an eye 11 to enable the mole 1 to be connected to a steel winch cable (not shown).

The rear portion of the mole 1 is provided with a clamping means 4 in the form of a sleeve 12 secured to the body portion 3 and being of slightly smaller external diameter than that of the body portion 3. The sleeve 12, in use, receives the end of the new main 13 which is of a flexible material such as plastics. The end of the new main 13 is first surrounded by a protective plas-

tics sleeve 14 and the main 13 and sleeve 14 are pushed into the clamping sleeve 12. This is arranged to have an internal diameter approximately equal to the internal diameter of the new main 13 so that this fits securely within and is tightly gripped and clamped by the clamping sleeve 12.

The cutters 7 are arranged to be spaced equiangularly around the axis of the cutting face 5 as shown in Figures 2 and 3 and the taper of the cutting face 5 prevents the mole 1 from twisting and turning on its horizontal axis thereby preventing undue strain on the new main and associated pneumatic feedlines (not shown).

In use, the ground at either end of the existing cast iron main 8 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 8 from one end and is secured to the shackle housing 10 via the eye 11. The new plastic main 13 and its sheath 14 are then clamped to the clamping sleeve 12. The new plastics main 13 can be of the same or slightly larger internal diameter than the existing cast iron main 8. The head portion 2 of the mole 1 is then inserted into the existing cast iron main 8 until the cutting edges 6 engage the end of the main 8 as shown in Figure 1.

The cable is then wound onto the winch so as to pull the mole 1 through the existing main 8. At the same time the rear portion 12 is acted upon by a pneumatic hammer (not shown) to drive the mole 1 into the main 8. The combined tension and pneumatic pressure cause the mole 1 to move along the main 8 so that the cutting edges 7 engage the internal wall of the main 8 and cause the wall to fracture due to their intense localised pressure on the wall as the mole 1 moves there-through. The cylindrical body 3 widens out the internal diameter of the fractured main 8 since, in use, the body 3 is selected to have a diameter greater than that of the original internal diameter of the main 8. The body 3 also prevents debris from the fractured main and earth from falling into the pathway created for the new main. As the mole 1 proceeds along the now fractured main 8 it tows the new main 13 and its associated sheath 14 with it, the internal diameter of the new main 13 being equal to or slightly larger than that of the existing main 8. When the new main 13 is finally in position, the new main 13 and its sheath 14 are removed from the clamping sleeve 12.

As a general rule the outer diameter of the body portion 3 of the mole 1 is arranged to be about $\frac{1}{8}$ " (3.17 mm) greater than the outer diameter of the existing main and the outer diameter of the clamping sleeve 12 is about $\frac{1}{8}$ " (3.17 mm) less in diameter than that of the cylindrical body portion 3 of the mole 1.

Referring to Figures 4 to 7, Figure 4 shows a steel mole 21 having a front portion consisting of a head portion 22 and a body portion 23 and a rear portion having a clamping means 24 for clamping a new main.

The head portion 22 has a cutting face 25 comprising three or more pivotally mounted cut-

ting blades 26 (four are present on the mole shown in Figures 4 and 5). The blades 26 are disposed in elongated axially directed slots (not shown) in the wall of the head portion 22 and are pivotally mounted at their forward ends 27 to the wall of the head portion 22.

Referring to Figures 6 and 7 the blades 26 are arranged to be spaced equiangularly around the axis of the cutting face. Each blade 26 has a cutting edge 28 formed by two sloping sides 29, two parallel sides 30 adjoining the sloping sides 29 and a concave side 31 distal from the cutting edge 28 between the parallel sides 30.

Referring to Figures 4 and 5 the concave side 31 slopes away from the cutting edge 28 in a direction forwardly of the mole.

The body portion 23 has a cylindrical rear portion 32, a frustoconical portion 33 tapering forwardly of the mole and a cylindrical front portion 34 adjoining the slot forming walls (not shown) of the head portion 22.

The body portion 23 is provided with a circular centrally located through-going bore 35 (see Figure 5) which merges with a passageway 36 formed by the concave sides 31 of the blades 26 and the internal concave shaped walls (not shown) of the head portion slot forming walls. The passageway 36 merges with a circular centrally located through-going bore 37 located near the forward end of the head portion 23 beyond the pivoted ends 27 of the blades 26. The bore 27 is provided with a conical termination 38.

The bore 35 and passageway 36 house an hydraulically operated cylindrical ram 39 which is capable of movement within the bore 35 and passageway 36. The front of the ram 39 is engaged at all times with the concave sides 31 of the blades 26. When the blades 26 are in the closed position shown in Figure 4 the cutting edges 28 are axially aligned with the front portion 34 of the body portion 23. The concave sides 31 of the blades 26 extend further radially into the passageway 36 than do the internal concave shaped walls of the head portion slot forming walls (not shown) so as to permit the blades 26 to pivot outwardly from the closed position in Figure 4 to the open position in Figure 5 as the ram 39 is moved forwardly along the passageway 36 and encounters the radially inward slope of the concave sides 31.

The front end of the head portion 22 is provided with a housing 40 and an eye 41 similar to that shown in the mole of Figure 1 and for similar purposes.

The rear portion of mole 21 is provided with a clamping means 24 in the form of a clamping sleeve 42 similar to that shown in the mole in Figure 1. As in that mole, the clamping sleeve 42 is secured to the body portion 23 and is of slightly smaller diameter than the rear portion 32 of the body portion 23. The new plastics main 43 and its protective sheath 44 are secured and clamped to the clamping sleeve 42 in exactly the same manner as previously described for the mole shown in Figure 1.

In use, as with the mole described in Figure 1, the ground at either end of the existing cast iron main 45 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 45 from one end and is secured to the housing 40 via the eye 41. The new plastics main 43 and its sheath 4 are then clamped to the clamping sleeve 42. The new plastics main 43 can be of the same or slightly larger internal diameter than the existing cast iron main 45. The head portion 22 of the mole 21 is then inserted into the existing main 45 until a portion at least of the cutting blades 26 lie adjacent to the internal wall of the existing main 45 as shown in Figure 4. The ram 39 is actuated hydraulically to move forwardly within the passageway 36 to cause the blades 26 to pivot about their ends 27 to engage and fracture the cast iron main 45 by the intense localised pressure of their cutting edges 28 upon the internal wall of the main 45 as shown in Figure 5. After a portion of the main 45 has been cracked open the ram 39 is withdrawn to the position shown in Figure 4 so that the blades 26 return to the closed position of Figure 4. The winch cable (not shown) is then wound onto the winch so as to pull the mole 21 through the existing main 45 by an amount not exceeding the length of the blades 26. A next portion of the existing main 45 is then fractured by the method just described and the mole 21 is then pulled through the main 45 by a further amount not exceeding the blades 26. This process is repeated until the entire length of the existing main 45 has been fractured. As the mole 21 moves through the fractured main 45 the body portion 23 widens out the internal diameter of the fractured main 45 since, in use, the rear portion 32 of the body portion 23 is selected to have a diameter greater than that of the original internal diameter of the cast iron main 45.

The body portion 23 also prevents debris from the fractured main 45 and earth from falling into the pathway created for the new main 43. As the mole 21 proceeds along the fractured main, it tows the new main 43 with it, the internal diameter of the new main 43 being the same or slightly larger than that of the existing main 45. When the new main 43 is finally in position, the new main 43 and its sheath 4 are removed from the clamping sleeve 22.

Referring to Figure 8, the steel mole 51 comprises a front portion consisting of a head 52 tapering generally conically towards its front end and a cylindrical rear portion 53 incorporating clamping means 54 for clamping a cylindrical liner for the new main.

As shown more clearly in Figures 9 and 10 the head portion has a cutting face 55 comprising three blades 56, 57 and 58 disposed in elongated axially directed slots in the wall of the head 52. Two lower blades 56 and 57 (shown in Figure 9) are attached rigidly in the slots so that they are fixed.

The other upper blade 58, which is wider and thicker than the lower blades, is pivotally mounted at its forward end 59 to the wall of the head portion 52.

The upper blade 58 pivots on a pin 60 extending through portions (not shown) of the head 52 of the mole 52, the portions forming a recess (not shown) to accommodate movement of the blade 58.

As shown in Figure 9, the blades 56 and 58 are spaced equiangularly around the axis of the cutting face which tapers forwardly to the front end of the mole 51. Each blade 56 to 58 has a cutting edge 60 formed by two sloping sides 61 and a base 62 distal from the cutting edge 60 and formed between parallel sides 63.

Referring to Figures 9 and 10 the head 52 of the mole 51 houses an hydraulically actuated piston 64 slidable within a cylindrical bore 65 within the head 52. The bore 65 has a portion 66 in which the piston 64 is slidable. An internally threaded cylindrical recess 67 is located above the portion 66 and receives an externally threaded stop ring 68. The stop ring 68 serves to limit the extent of upward movement of the piston 64 when it engages with a lowermost stop collar 69 forming an integral part of the piston 64.

As shown in Figures 8 and 10 the head 52 is provided with a hydraulic fluid channel 70 which at one end communicates with the bore 65 below the piston 64 and terminates in a threaded bore 71 of wider diameter at the front end of the head 52. The threaded bore 71 serves to receive the threaded connector of a hydraulic hose coupling 72.

While not shown, the front end of head 52 is recessed laterally on two sides to receive and engage the cross-pieces 73 of two adjacent T-shaped winch cable connecting plates 74 (only one plate 74 shown in the drawings). The plates 74 are connected to each other and to the front end of the head 52 by a pair of connecting pins 75 and 76 via the front end of the head portion 52. The uprights 77 of the connecting plates 74 extend forwardly of the mole 51 and are connected together by a pin 78 which also forms a connecting point for a cable 79 of a winch (not shown).

Referring to Figure 8, the rear 53 of the mole 51 comprises a generally hollow cylinder adjoining the conically tapering mole head 52. The mole 51 forms a housing for a pneumatically actuated hammer device 80.

The hammer 80 has head portion 81 projecting into an internal bore 82 formed in the head 52 of the mole 51, the rear 83 of the hammer 80 being axially disposed with clearance in the cylindrical rear portion 53 of the mole 51.

The head portion 81 of the hammer 80 comprises a forwardly conically tapering portion 84 terminating in a cylindrical end 85. The diameter of the end 85 is less than the diameter of the adjoining end of the conically tapering portion 84 so that there is an annular shoulder 86 formed between the portion 84 and the hammer end 85.

As shown in Figure 8 the portion 84 and the end 85 of the hammer head 81 are, in use, able to co-operatively engage in corresponding portions of the internal bore 82, these portions also forming an annular shoulder for co-operation with the annular shoulder 86 in the hammer head 81. A rear part of the hammer head portion 84 is disposed

axially with clearance in wider forwardly conically tapering portion 90 of the internal bore 82, the portion 84 terminating within the rear 53 of the mole 51.

The rear 83 of the hammer 80 comprises a cylindrical portion 91 terminating in a rearwardly tapering conical portion 92 which is provided with a coupling (not shown) for an air hose 93.

In use, compressed air supplied to the hammer 80 through the hose 93 causes the hammer 80 to reciprocate in the conventional manner to drive the mole 51 through the existing main 94 by the percussive action of the hammer head 81 upon the corresponding co-operating portions of the internal bore 82 of the mole 51.

The means 54 for clamping the liner 95 to the mole 51 comprises a steel ring 96 for engaging the rear end of the liner 95, a looped cable 97 connected to the ring 96, a tensioning cable 98 connected to the cable 97, a clamping cup 99 for engaging the far end of the liner 95 and a locking device 100 for locking the cable 98 against the cup 99. The cable 98 is coupled by a conventional hitch 101 at one end to the looped cable 97.

The steel ring 96 is secured as by welding with and to the internal wall of the rear portion 53 of the mole 51. The ring 96 is formed with holes (not shown) to enable the ends of the looped steel cable 97 to be secured thereto.

The clamping cup 99 which is also of steel is adapted to receive and locate the far end of the liner 95 and is apertured (not shown) for the passage therethrough of the air hose 93 and of the tensioning cable 98.

In use of the mole 51, as with the moles previously described the ground at either end of the existing cast iron main 94 is excavated to expose the ends of the main 94. The steel cable 79 of a motorised winch is then fed through the main 94 from one end and is secured to mole 51 located at the other end of the main 94. The cable 79 is connected to the winch cable plates 74 by way of the winch cable pin 78. Next the hydraulic hose 94 is fed through the same end of the main 94 as the cable 79 and is coupled to the fluid bore 71 in the mole head 52 by way of the hose coupling 72.

In the next stage, the liner 95 is clamped to the mole 51. Initially, the looped cable 97 is secured to the ring 96 and the cable 97 is then secured to the tensioning cable 98. The liner 95 is then pushed up the cylindrical portion 53 of the mole 51 until one end of the liner 95 engages with the ring 96. The clamping cup 99 is then slid along the tensioning cable 98 and the air hose 93 until the other end of the liner 95 is located within and engages with the cup 99. The tensioning cable 98 is then tensioned and locked by the locking device 100 and the liner 95 is therefore clamped compressively between the clamping cup 99 and the ring 96. As shown in Figures 8 and 10 the internal diameter of the liner 95 is greater than the internal diameter of the existing cast iron main 94.

The head portion 52 of the mole 51 is then inserted into the cast iron main 103 until the cutting edges 60 of the blades 56, 57 and 58

engage the end of the main 103 as shown in the drawings. The pneumatic hammer 80 is actuated by supplying compressed air to its rear end by way of the air hose 93 so that the hammer 80 percussively drives the mole 51 through the main 94.

Simultaneously the mole 51 is drawn through the main 94 by the cable 79 which serves to guide the mole 51 axially through the main 94.

As the mole 51 moves through the main 103 the cutting edges 60 engage the internal wall of the main 94 and cause it to fracture. Since the cylindrical portion 53 of the mole 51 has a greater external diameter than the internal diameter of the main 94, the internal diameter of the fractured main 94 is widened out. The body 53 of the mole 51 also serves to provide clearance for the passage of the liner 95 therethrough and prevents debris from the fractured main and earth from falling into the pathway created for the liner 95.

Should the mole 51 encounter an obstruction in the main 94, such as a flange which narrows the internal diameter of the main 94, the movable blade 58 is pivoted outwardly to fracture the obstruction and provide a clearance for the liner. In this case hydraulic fluid is pumped to the piston 64 via the hose 103, duct 70 and the cylinder bore 65. The fluid pressure is relaxed immediately after the obstruction has been fractured so that the piston 64 relaxes and the blade 58 returns to its closed position. The hose 103 is of course moved simultaneously forward with the mole 51.

The liner 95 is pushed through and out of the main 103 after complete fracture thereof.

Finally, the mole 51, together with the associated locking device 100 is removed from the liner 95. The new main (not shown) may then be pushed manually or otherwise through the liner 95 which therefore forms a protective sleeve for the new main.

The new main may be of any convenient plastics material such as polyethylene or pvc while the liner is of a much tougher wear resistant plastics material.

Claims

1. A method for replacing or preparing for replacement a buried existing main with a new main, the method comprising dividing the buried main in situ to form discrete portions and moving the portions radially outwardly to widen the bore of the main to form a passage having a diameter at least as great as the external diameter of the new main or a liner for the existing main, maintaining sufficient clearance through the passage for movement therethrough of a new main or a liner for the existing main and moving the new main or liner endwise into the passage simultaneously with the widening of the bore of the buried existing main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner, characterised in causing at least a portion of the radially outward movement of the divided por-

tions to occur substantially simultaneously with the formation of the portions.

2. A method as claimed in claim 1, characterised in that the buried main (8, 94) is fractured and the passage is formed by a mole (1, 51) which is moved through the buried main (8, 94) and which has a portion (2, 52) which both fractures the buried main (8, 94) to produce debris and also causes the debris to be moved radially outwards substantially simultaneously with the formation of the debris.

3. A method as claimed in claim 2, characterised in that the portion is a tapering cylinder (2, 52).

4. A method as claimed in claim 3, characterised in that the tapering cylinder (2, 52) is frusto-conical.

5. A method as claimed in any of claims 2 to 4, characterised in that the portion (2, 52) has at least one main fracturing member (7, 56, 57, 58) adapted to engage and fracture the internal wall of the buried main (8, 94).

6. A method as claimed in claim 5, characterised in that there are a plurality of such members (7, 56, 57, 58).

7. A method as claimed in claim 6, characterised in that at least one of the members (58) is retractably movable outwards to engage and fracture the internal wall of the buried main (94).

8. A method as claimed in any of claims 2 to 7, characterised in that the mole (1, 51) is driven through the buried main (8, 94).

9. A method as claimed in claim 8, characterised in that the mole (1, 51) is percussively driven through the buried main (8, 94).

10. A method as claimed in claim 2, characterised in that the buried main (45) is fractured and the passage is formed by a mole (21) which is moved through the buried main (45) and which has at least one retractably outwardly movable member (26) to engage and fracture the buried main (45) to produce debris and also cause the debris to be moved radially outwards substantially simultaneously with the formation of the debris.

11. A method as claimed in claim 10, characterised in that the mole has a plurality of such members (26).

12. A method as claimed in any of claims 2 to 11, characterised in that the new main (13, 43) or the liner (14, 44, 95) is connected to the rear end of the mole (1, 21, 51).

13. A method as claimed in any of the preceding claims, characterised in that the internal diameter of the new main (13, 43) is equal to or greater than the internal diameter of the buried main (8, 45).

14. A method as claimed in any of the preceding claims, characterised in that the internal diameter of the new main (13, 43) is equal to or greater than the external diameter of the buried main (8, 45).

15. A method as claimed in any of the preceding claims, characterised in that the diameter of the passage is greater than the internal diameter of the buried main (8, 45, 94).

16. A method as claimed in any of the preceding

claims, characterised in that the diameter of the passage is equal to or greater than the external diameter of the buried main (8, 45, 94).

17. A method as claimed in any of the preceding claims, characterised in that the buried main (8, 45, 94) is of cast iron.

Patentansprüche

1. Verfahren für den Austausch oder die Vorbe-
reitung des Austausches einer bestehenden
Unterflurleitung gegen eine neue Leitung, mit den
Verfahrensschritten des Aufteilens der Unterflur-
leitung an Ort und Stelle zur Bildung von Einzel-
teilstücken und des Bewegens der Einzelteilstücke
radial auswärts, um die Bohrung der Leitung
aufzuweiten und dadurch eine Passage zu bilden,
deren Durchmesser mindestens so groß wie der
Außendurchmesser der neuen Leitung oder einer
Auskleidung für die bestehende Leitung ist, des
Aufrechterhaltens eines ausreichenden Spiels
zum Bewegen einer neuen Leitung oder Ausklei-
dung für die bestehende Leitung durch die Pas-
sage hindurch und des Bewegens der neuen
Leitung oder Auskleidung axial in die Passage
gleichzeitig mit dem Aufweiten der Bohrung der
bestehenden Unterflurleitung, wobei die Ausklei-
dung als Schutzhülle für die neue Leitung dient,
wenn diese nachfolgend in die Auskleidung
bewegt wird, dadurch gekennzeichnet, daß
zumindest ein Teil der radialen Auswärtsbewe-
gung der Einzelteilstücke im wesentlichen gleich-
zeitig mit der Bildung der Einzelteilstücke vorge-
nommen wird.

2. Verfahren nach Anspruch 1, dadurch gekenn-
zeichnet, daß die Unterflurleitung (8, 94) aufgeris-
sen und die Passage durch eine Mole (1, 51)
gebildet wird, die durch die Unterflurleitung (8,
94) hindurchbewegt wird und die ein Teilstück (2,
52) aufweist, das sowohl die Unterflurleitung (8,
94) aufreißt, um Trümmer zu erzeugen, als auch
die Trümmer veranlaßt, sich im wesentlichen
gleichzeitig mit ihrer Bildung radial nach außen zu
bewegen.

3. Verfahren nach Anspruch 2, dadurch gekenn-
zeichnet, daß das Teilstück ein zugespitzter Zylin-
der (2, 52) ist.

4. Verfahren nach Anspruch 3, dadurch gekenn-
zeichnet, daß der zugespitzte Zylinder (2, 52)
kegelstumpfförmig ausgebildet ist.

5. Verfahren nach einem der Ansprüche 2 bis 4,
dadurch gekennzeichnet, daß das Teilstück (2, 52)
zumindest einen Hauptaufreißbauteil (7, 56, 57,
58) aufweist, der mit der Innenwand der Unter-
flurleitung (8, 84) in Wirkverbindung steht und
diese aufreißt.

6. Verfahren nach Anspruch 5, dadurch gekenn-
zeichnet, daß eine Vielzahl solcher Bauteile (7, 56,
57, 58) vorgesehen ist.

7. Verfahren nach Anspruch 6, dadurch gekenn-
zeichnet, daß zumindest einer der Bauteile (58)
rückstellbar nach außen bewegbar ist, um mit der
Innenwand der Unterflurleitung (94) in Wirkver-
bindung gebracht zu werden und diese aufzubre-
chen.

8. Verfahren nach einem der Ansprüche 2 bis 7, dadurch gekennzeichnet, daß die Mole (1, 51) durch die Unterflurleitung (8, 94) hindurchgetrieben wird.

9. Verfahren nach Anspruch 8, dadurch gekennzeichnet, daß die Mole (1, 51) stoßend oder schlagend durch die Unterflurleitung (8, 94) hindurchgetrieben wird.

10. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Unterflurteilung (45) aufgerissen und die Passage durch eine Mole (21) gebildet wird, die durch die Unterflurleitung (45) hindurchbewegt wird und zumindest einen rückstellbar nach außen bewegbaren Bauteil (26) aufweist, der durch Einwirken auf die Unterflurleitung (45) diese aufreißt, um Trümmer zu erzeugen und diese im wesentlichen gleichzeitig mit ihrer Entstehung radial nach außen zu bewegen.

11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Mole eine Vielzahl solcher Bauteile (26) aufweist.

12. Verfahren nach einem der Ansprüche 2 bis 11, dadurch gekennzeichnet, daß die neue Leitung (13, 43) oder Auskleidung (14, 44, 95) mit dem hinteren Ende der Mole (1, 21, 51) verbunden ist.

13. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Innendurchmesser der neuen Leitung (13, 43) gleich dem oder größer als der Innendurchmesser der Unterflurleitung (8, 45) ist.

14. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Innendurchmesser der neuen Leitung (13, 43) gleich dem oder größer als der Außendurchmesser der Unterflurleitung (8, 45) ist.

15. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Durchmesser der Passage größer als der Innendurchmesser der Unterflurleitung (8, 45, 94) ist.

16. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Durchmesser der Passage gleich dem oder größer als der Außendurchmesser der Unterflurleitung (8, 45, 94) ist.

17. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Unterflurleitung (8, 45, 94) aus Gußeisen besteht.

Revendications

1. Procédé pour remplacer ou préparer le remplacement d'une canalisation enterrée existante par une nouvelle canalisation, le procédé consistant à éclater sur place la canalisation enterrée pour former des morceaux physiquement distincts et à déplacer les morceaux radialement vers l'extérieur pour élargir la lumière de la canalisation afin de former un passage ayant un diamètre au moins aussi grand que le diamètre extérieur de la nouvelle canalisation ou d'une chemise pour la canalisation existante, à maintenir un dégagement suffisant dans le passage pour permettre un mouvement dans celui-ci d'une nouvelle canalisation ou d'une chemise pour la canalisation existante, et à introduire en bout la nouvelle canalisa-

tion ou la chemise dans le passage en même temps que la lumière de la canalisation enterrée existante et élargie, la chemise étant destinée à servir de gaine protectrice pour la nouvelle canalisation lorsque celle-ci est ensuite introduite dans la chemise, caractérisé en ce qu'il consiste à amener au moins une partie du mouvement radial vers l'extérieur des morceaux éclatés à se produire à peu près simultanément à la formation des morceaux.

2. Procédé selon la revendication 1, caractérisé en ce que la canalisation enterrée (8, 94) est fracturée et le passage est formé par une taupe (1, 51) qui est déplacée dans la canalisation enterrée (8, 94) et qui comporte une partie (2, 52) qui à la fois fracture la canalisation enterrée (8, 94) pour produire des débris et amène aussi les débris à être déplacés radialement vers l'extérieur à peu près simultanément à leur formation.

3. Procédé selon la revendication 2, caractérisé en ce que la partie est un cylindre effilé (2, 52).

4. Procédé selon la revendication 3, caractérisé en ce que le cylindre effilé (2, 52) est tronconique.

5. Procédé selon l'une quelconque des revendications 2 à 4, caractérisé en ce que la partie (2, 52) comporte au moins un élément (7, 56, 57, 58) de fracturation de canalisation conçu pour porter contre la paroi intérieure de la canalisation enterrée (8, 94) et pour la fracturer.

6. Procédé selon la revendication 5, caractérisé en ce qu'il y a plusieurs de ces éléments (7, 56, 57, 58).

7. Procédé selon la revendication 6, caractérisé en ce qu'au moins l'un des éléments (58) peut être déplacé de façon rétractable vers l'extérieur pour porter contre la paroi interne de la canalisation enterrée (94) et la fracturer.

8. Procédé selon l'une quelconque des revendications 2 à 7, caractérisé en ce que la taupe (1, 51) est entraînée dans la canalisation enterrée (8, 94).

9. Procédé selon la revendication 8, caractérisé en ce que la taupe (1, 51) est entraînée par percussion dans la canalisation enterrée (8, 94).

10. Procédé selon la revendication 2, caractérisé en ce que la canalisation enterrée (45) est fracturée et le passage est formé par une taupe (21) qui est déplacée dans la canalisation enterrée (45) et qui comporte au moins un élément (26) mobile de façon rétractable vers l'extérieur pour porter contre la canalisation enterrée (45) et la fracturer afin de produire des débris et pour aussi amener les débris à être déplacés radialement vers l'extérieur à peu près simultanément à leur formation.

11. Procédé selon la revendication 10, caractérisé en ce que la taupe comporte plusieurs de ces éléments (26).

12. Procédé selon l'une quelconque des revendications 2 à 11, caractérisé en ce que la nouvelle canalisation (13, 43) ou la chemise (14, 44, 95) est reliée à l'extrémité arrière de la taupe (1, 21, 51).

13. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre intérieur de la nouvelle canalisation (13, 43) est égal ou supérieur au diamètre intérieur de la canalisation enterrée (8, 45).

14. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre intérieur de la nouvelle canalisation (13, 43) est égal ou supérieur au diamètre extérieur de la canalisation enterrée (8, 45).

15. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre du passage est supérieur au diamètre intérieur de la canalisation enterrée (8, 45, 94).

16. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre du passage est égal ou supérieur au diamètre extérieur de la canalisation enterrée (8, 45, 94).

17. procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que la canalisation enterrée (8, 45, 94) est en fonte.

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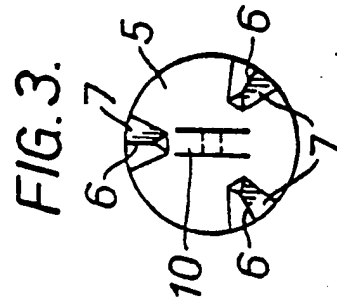
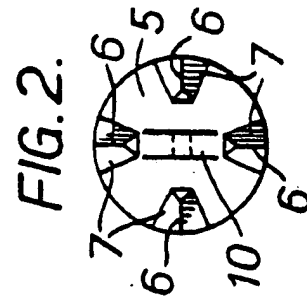
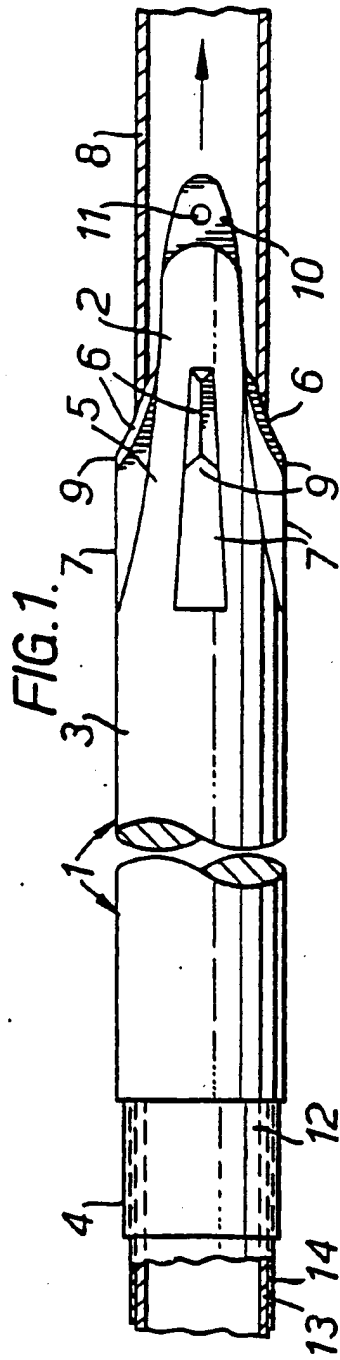


FIG. 4.

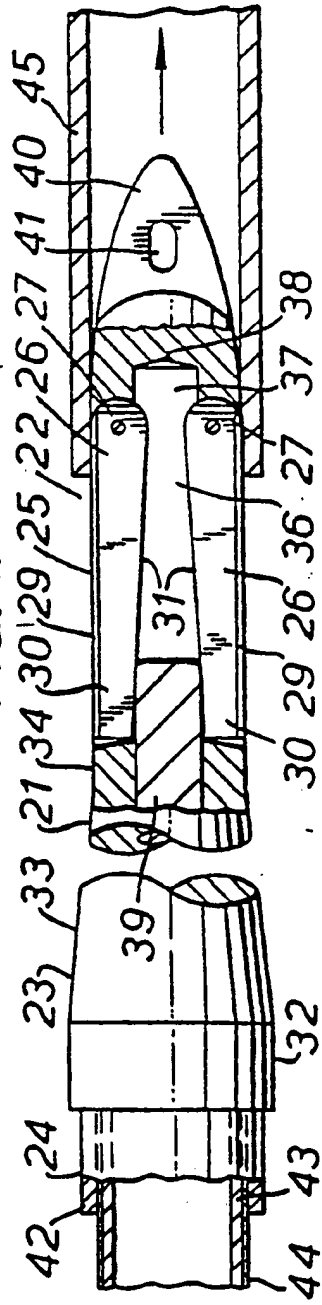


FIG. 5.

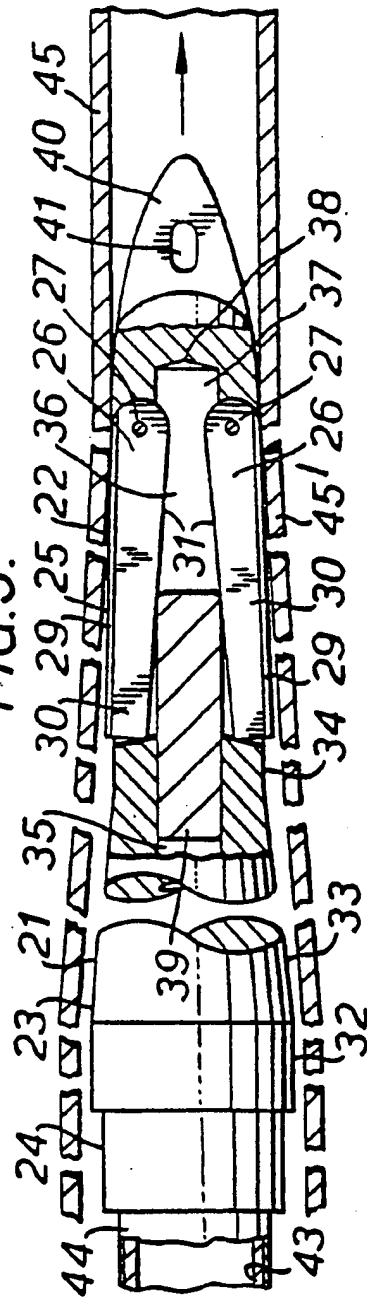


FIG. 6.

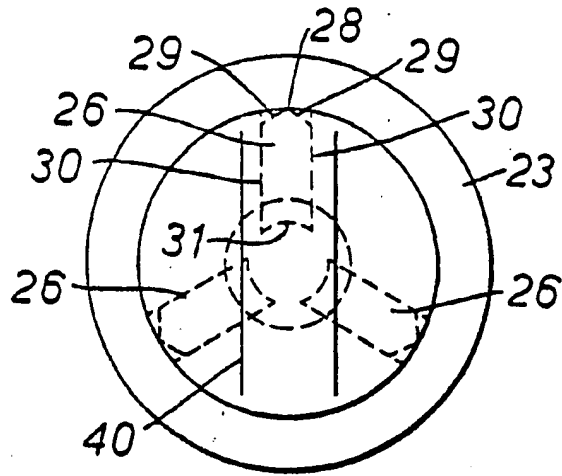
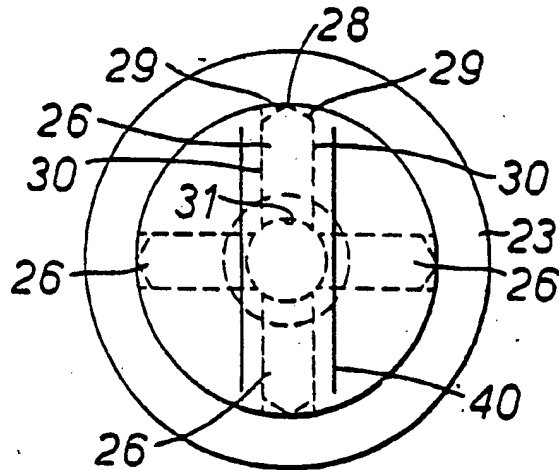


FIG. 7.



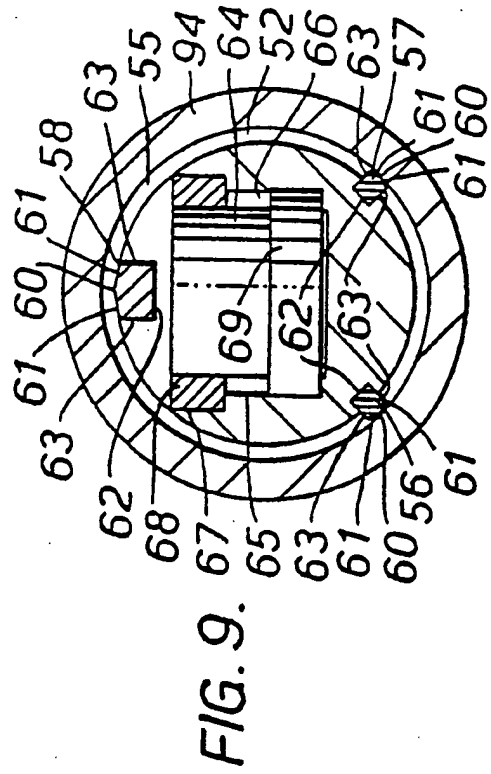
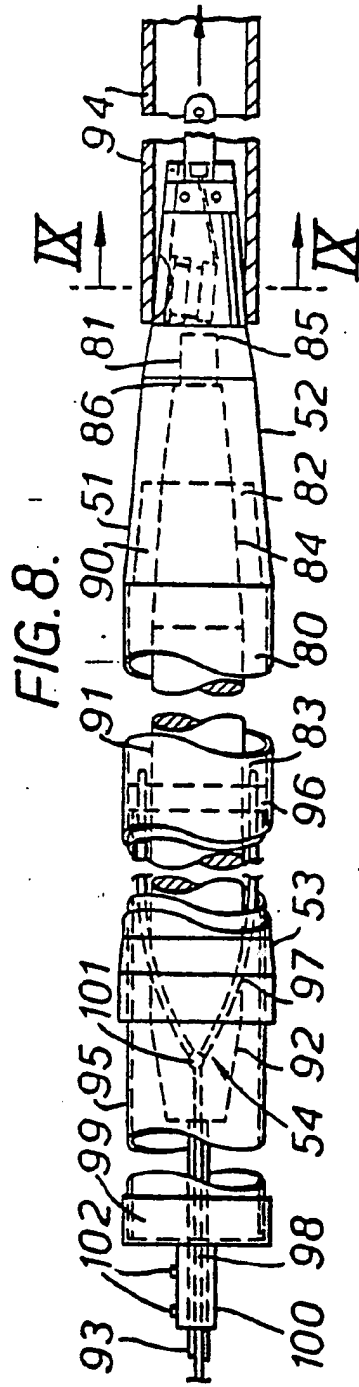
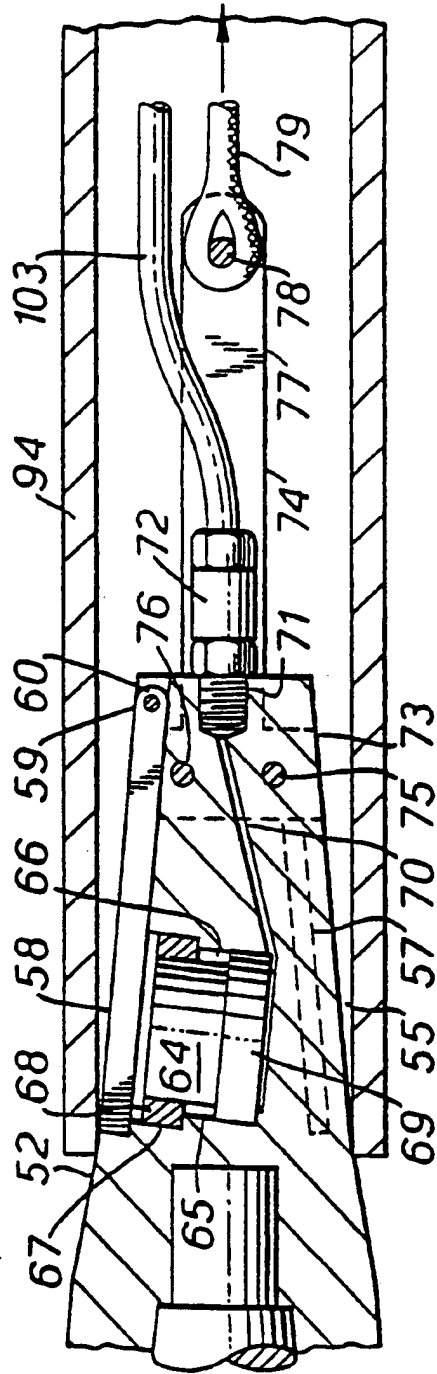


FIG. 10.





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EP 0 094 694 B2

Description

The present invention relates to the replacement or the preparation for replacement of an existing main, particularly an existing cast iron gas main, with a new main and is particularly concerned with a method for enabling this replacement to be carried out.

This application is divided out from the copending European Patent 0053480 which is directed to a device for replacing an existing main.

Mains have to be replaced for a number of reasons, for instance, the existing main may be in poor condition or the existing main may not be of sufficient capacity to accommodate a modified load.

The usual means of replacing a gas main involves the use of costly and labour intensive total excavation of the surrounding ground. Alternatively, if total excavation is avoided and the new main is merely inserted into the existing main, it will, by necessity, be of smaller internal diameter than the existing main and thus will be of smaller gas carrying capacity.

US Patent Specification No. 3181302 is directed to an apparatus for replacing a pipe occupying an underground passageway through which a substantially horizontal axis extends. The apparatus comprises a pipe splitting cutter which is adapted to be drawn through the pipe so as to progressively slit the pipe into two longitudinal halves. These are then spread apart by a spreader to enable a new pipe which is previously coupled to the apparatus to occupy the position of the existing pipe.

It is an object of the present invention to enable an existing fracturable main to be replaced or prepared for replacement by a new main whereby problems associated with the debris and earth formed on fracturing the main are avoided.

According to the present invention, there is provided a method according to claim 1.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a side view of a first embodiment of the mole shown in use,

Figure 2 is an end view of the mole cutting face shown in Figure 1 and having four cutting edges,

Figure 3 is an end view of the mole cutting face shown in Figure 1 and having three cutting edges,

Figure 4 is a side view partly in section of a second embodiment of the mole shown at the commencement of operation,

Figure 5 is a view of the mole shown in Figure 4 during operation,

Figure 6 is an end view of the mole cutting face shown in Figures 4 and 5 and having three cutters shown in hidden detail,

Figure 7 is an end view of the mole cutting face shown in Figures 4 and 5 and having four cutters

shown in hidden detail,

Figure 8 is a side view of a third embodiment of the mole shown in use and broken away in part to reveal internal detail,

Figure 9 is a view along the lines IX-IX of Figure 8, and

Figure 10 is a close up view of the front of the mole partly in section.

Referring to the Figures 1 to 3, Figure 1 shows a steel mole 1 having a front portion consisting of a head portion 2 and a cylindrical body portion 3 and a rear portion having clamping means 4 for clamping a new main.

The head portion 2 has a cutting face 5 comprising three or more cutting edges 6 formed by grinding high tensile steel cutters 7 (four cutters are shown in Figures 1 and 2). The cutters 7 are housed in keyways (not shown) in the head portion 2, which is in the form of a cylinder tapering towards the front end of the mole, the cutters 7 being attached to the head portion 2 by means of bolts (not shown) so that the cutters 7 are removable from the head portion 2. The cutting face 5 tapers radially inwardly in the direction of the forward end of the mole 1, that is, the radii of the cutting edges 6 decrease towards the forward end of the mole 1 so as to enable the cutting face 5 to exert a continuously increasing cutting action on the existing main 8 as the mole 1 moves therethrough.

The cutting face 5 terminates at rearward points 9 on the head portion 2, which points 9 are concentrically aligned with the periphery of the body portion 3 and the keyways are arranged on the head portion 2 so that the cutters 7 and their cutting edges 6 in position on the mole 1 lie in an axial plane of the mole 1.

The front end of the head portion 2 is provided with a housing 10 cast into the head portion 2 and provided with an eye 11 to enable the mole 1 to be connected to a steel winch cable (not shown).

The rear portion of the mole 1 is provided with a clamping means 4 in the form of a sleeve 12 secured to the body portion 3 and being of slightly smaller external diameter than that of the body portion 3. The sleeve 12, in use, receives the end of the new main 13 which is of a flexible material such as plastics. The end of the new main 13 is first surrounded by a protective plastics sleeve 14 and the main 13 and sleeve 14 are pushed into the clamping sleeve 12. This is arranged to have an internal diameter approximately equal to the internal diameter of the new main 13 so that this fits securely within and is tightly gripped and clamped by the clamping sleeve 12.

The cutters 7 are arranged to be spaced equian-gularly around the axis of the cutting face 5 as shown in Figures 2 and 3 and the taper of the cutting face 5 prevents the mole 1 from twisting and turning on its horizontal axis thereby preventing undue strain on the new main and associated pneumatic feedlines (not shown).

In use, the ground at either end of the existing cast iron main 8 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 8 from one end and is secured to the shackle housing 10 via the eye 11. The new plastic main 13 and its sheath 14 are then clamped to the clamping sleeve 12. The new plastics main 13 can be of the same or slightly larger internal diameter than the existing cast iron main 8. The head portion 2 of the mole 1 is then inserted into the existing cast iron main 8 until the cutting edges 6 engage the end of the main 8 as shown in Figure 1.

The cable is then wound onto the winch so as to pull the mole 1 through the existing main 8. At the same time the rear portion 12 is acted upon by a pneumatic hammer (not shown) to drive the mole 1 into the main 8. The combined tension and pneumatic pressure cause the mole 1 to move along the main 8 so that the cutting edges 7 engage the internal wall of the main 8 and cause the wall to fracture due to their intense localised pressure on the wall as the mole 1 moves therethrough. The cylindrical body 3 widens out the internal diameter of the fractured main 8 since, in use, the body 3 is selected to have a diameter greater than that of the original internal diameter of the main 8. The body 3 also prevents debris from the fractured main and earth from falling into the pathway created for the new main. As the mole 1 proceeds along the now fractured main 8 it tows the new main 13 and its associated sheath 14 with it, the internal diameter of the new main 13 being equal to or slightly larger than that of the existing main 8. When the new main 13 is finally in position, the new main 13 and its sheath 14 are removed from the clamping sleeve 12.

As a general rule the outer diameter of the body portion 3 of the mole 1 is arranged to be about $\frac{1}{8}$ " (3.17 mm) greater than the outer diameter of the existing main and the outer diameter of the clamping sleeve 12 is about $\frac{1}{8}$ " (3.17 mm) less in diameter than that of the cylindrical body portion 3 of the mole 1.

Referring to Figures 4 to 7, Figure 4 shows a steel mole 21 having a front portion consisting of a head portion 22 and a body portion 23 and a rear portion having a clamping means 24 for clamping a new main.

The head portion 22 has a cutting face 25 comprising three or more pivotally mounted cutting blades 26 (four are present on the mole shown in Figures 4 and 5). The blades 26 are disposed in elongated axially directed slots (not shown) in the wall of the head portion 22 and are pivotally mounted at their forward ends 27 to the wall of the head portion 22.

Referring to Figures 6 and 7 the blades 26 are arranged to be spaced equiangularly around the axis of the cutting face. Each blade 26 has a cutting edge 28 formed by two sloping sides 29, two parallel sides 30 adjoining the sloping sides 29 and a concave side 31

distal from the cutting edge 28 between the parallel sides 30.

Referring to Figures 4 and 5 the concave side 31 slopes away from the cutting edge 28 in a direction forwardly of the mole.

The body portion 23 has a cylindrical rear portion 32, a frustoconical portion 33 tapering forwardly of the mole and a cylindrical front portion 34 adjoining the slot forming walls (not shown) of the head portion 22.

The body portion 23 is provided with a circular centrally located through-going bore 35 (see Figure 5) which merges with a passageway 36 formed by the concave sides 31 of the blades 26 and the internal concave shaped walls (not shown) of the head portion slot forming walls. The passageway 36 merges with a circular centrally located through-going bore 37 located near the forward end of the head portion 23 beyond the pivotted ends 27 of the blades 26. The bore 37 is provided with a conical termination 38.

The bore 35 and passageway 36 house an hydraulically operated cylindrical ram 39 which is capable of movement within the bore 35 and passageway 36. The front of the ram 39 is engaged at all times with the concave sides 31 of the blades 26. When the blades 26 are in the closed position shown in Figure 4 the cutting edges 28 are axially aligned with the front portion 34 of the body portion 23. The concave sides 31 of the blades 26 extend further radially into the passageway 36 than do the internal concave shaped walls of the head portion slot forming walls (not shown) so as to permit the blades 26 to pivot outwardly from the closed position in Figure 4 to the open position in Figure 5 as the ram 39 is moved forwardly along the passageway 36 and encounters the radially inward slope of the concave sides 31.

The front end of the head portion 22 is provided with a housing 40 and an eye 41 similar to that shown in the mole of Figure 1 and for similar purposes.

The rear portion of mole 21 is provided with a clamping means 24 in the form of a clamping sleeve 42 similar to that shown in the mole in Figure 1. As in that mole, the clamping sleeve 42 is secured to the body portion 23 and is of slightly smaller diameter than the rear portion 32 of the body portion 23. The new plastics main 43 and its protective sheath 44 are secured and clamped to the clamping sleeve 42 in exactly the same manner as previously described for the mole shown in Figure 1.

In use, as with the mole described in Figure 1, the ground at either end of the existing cast iron main 45 is excavated to expose those ends. The steel cable of a motorised winch is fed through the main 45 from one end and is secured to the housing 40 via the eye 41. The new plastics main 43 and its sheath 44 are then clamped to the clamping sleeve 42. The new plastics main 43 can be of the same or slightly larger internal diameter than the existing cast iron main 45.

The head portion 22 of the mole 21 is then inserted into the existing main 45 until a portion at least of the cutting blades 26 lie adjacent to the internal wall of the existing main 45 as shown in Figure 4. The ram 39 is actuated hydraulically to move forwardly within the passageway 36 to cause the blades 26 to pivot about their ends 27 to engage and fracture the cast iron main 45 by the intense localised pressure of their cutting edges 28 upon the internal wall of the main 45 as shown in Figure 5. After a portion of the main 45 has been cracked open the ram 39 is withdrawn to the position shown in Figure 4 so that the blades 26 return to the closed position of Figure 4. The winch cable (not shown) is then wound onto the winch so as to pull the mole 21 through the existing main 45 by an amount not exceeding the length of the blades 26. A next portion of the existing main 45 is then fractured by the method just described and the mole 21 is then pulled through the main 45 by a further amount not exceeding the blades 26. This process is repeated until the entire length of the existing main 45 has been fractured. As the mole 21 moves through the fractured main 45 the body portion 23 widens out the internal diameter of the fractured main 45 since, in use, the rear portion 32 of the body portion 23 is selected to have a diameter greater than that of the original internal diameter of the cast iron main 45.

The body portion 23 also prevents debris from the fractured main 45 and earth from falling into the pathway created for the new main 43. As the mole 21 proceeds along the fractured main, it tows the new main 43 with it, the internal diameter of the new main 43 being the same or slightly larger than that of the existing main 45. When the new main 43 is finally in position, the new main 43 and its sheath 44 are removed from the clamping sleeve 22.

Referring to Figure 8, the steel mole 51 comprises a front portion consisting of a head 52 tapering generally conically towards its front end and a cylindrical rear portion 53 incorporating clamping means 54 for clamping a cylindrical liner for the new main.

As shown more clearly in Figures 9 and 10 the head portion has a cutting face 55 comprising three blades 56, 57 and 58 disposed in elongated axially directed slots in the wall of the head 52. Two lower blades 56 and 57 (shown in Figure 9) are attached rigidly in the slots so that they are fixed.

The other upper blade 58, which is wider and thicker than the lower blades, is pivotally mounted at its forward end 59 to the wall of the head portion 52.

The upper blade 58 pivots on a pin 60 extending through portions (not shown) of the head 52 of the mole 52, the portions forming a recess (not shown) to accommodate movement of the blade 58.

As shown in Figure 9, the blades 56 and 58 are spaced equiangularly around the axis of the cutting face which tapers forwardly to the front end of the mole 51. Each blade 56 to 58 has a cutting edge 60

formed by two sloping sides 61 and a base 62 distal from the cutting edge 60 and formed between parallel sides 63.

Referring to Figures 9 and 10 the head 52 of the mole 51 houses an hydraulically actuated piston 64 slidable within a cylindrical bore 65 within the head 52. The bore 65 has a portion 66 in which the piston 64 is slidable. An internally threaded cylindrical recess 67 is located above the portion 66 and receives an externally threaded stop ring 68. The stop ring 68 serves to limit the extent of upward movement of the piston 64 when it engages with a lowermost stop collar 69 forming an integral part of the piston 64.

As shown in Figures 8 and 10 the head 52 is provided with a hydraulic fluid channel 70 which at one end communicates with the bore 65 below the piston 64 and terminates in a threaded bore 71 of wider diameter at the front end of the head 52. The threaded bore 71 serves to receive the threaded connector of a hydraulic hose coupling 72.

While not shown, the front end of head 52 is recessed laterally on two sides to receive and engage the cross-pieces 73 of two adjacent T-shaped winch cable connecting plates 74 (only one plate 74 shown in the drawings). The plates 74 are connected to each other and to the front end of the head 52 by a pair of connecting pins 75 and 76 via the front end of the head portion 52. The uprights 77 of the connecting plates 74 extend forwardly of the mole 51 and are connected together by a pin 78 which also forms a connecting point for a cable 79 of a winch (not shown).

Referring to Figure 8, the rear 53 of the mole 51 comprises a generally hollow cylinder adjoining the conically tapering mole head 52. The mole 51 forms a housing for a pneumatically actuated hammer device 80.

The hammer 80 has head portion 81 projecting into an internal bore 82 formed in the head 52 of the mole 51, the rear 83 of the hammer 80 being axially disposed with clearance in the cylindrical rear portion 53 of the mole 51.

The head portion 81 of the hammer 80 comprises a forwardly conically tapering portion 84 terminating in a cylindrical end 85. The diameter of the end 85 is less than the diameter of the adjoining end of the conically tapering portion 84 so that there is an annular shoulder 86 formed between the portion 84 and the hammer end 85.

As shown in Figure 8 the portion 84 and the end 85 of the hammer head 81 are, in use, able to co-operatively engage in corresponding portions of the internal bore 82, these portions also forming an annular shoulder for co-operation with the annular shoulder 86 in the hammer head 81. A rear part of the hammer head portion 84 is disposed axially with clearance in wider forwardly conically tapering portion 90 of the internal bore 82, the portion 84 terminating within the rear 53 of the mole 51.

The rear 83 of the hammer 80 comprises a cylindrical portion 91 terminating in a rearwardly tapering conical portion 92 which is provided with a coupling (not shown) for an air hose 93.

In use, compressed air supplied to the hammer 80 through the hose 93 causes the hammer 80 to reciprocate in the conventional manner to drive the mole 51 through the existing main 94 by the percussive action of the hammer head 81 upon the corresponding co-operating portions of the internal bore 82 of the mole 51.

The means 54 for clamping the liner 95 to the mole 51 comprises a steel ring 96 for engaging the rear end of the liner 95, a looped cable 97 connected to the ring 96, a tensioning cable 98 connected to the cable 97, a clamping cup 99 for engaging the far end of the liner 95 and a locking device 100 for locking the cable 98 against the cup 99. The cable 98 is coupled by a conventional hitch 101 at one end to the looped cable 97.

The steel ring 96 is secured as by welding with and to the internal wall of the rear portion 53 of the mole 51. The ring 96 is formed with holes (not shown) to enable the ends of the looped steel cable 97 to be secured thereto.

The clamping cup 99 which is also of steel is adapted to receive and locate the far end of the liner 95 and is apertured (not shown) for the passage therethrough of the air hose 93 and of the tensioning cable 98.

In use of the mole 51, as with the moles previously described the ground at either end of the existing cast iron main 94 is excavated to expose the ends of the main 94. The steel cable 79 of a motorised winch is then fed through the main 94 from one end and is secured to mole 51 located at the other end of the main 94. The cable 79 is connected to the winch cable plates 74 by way of the winch cable pin 78. Next the hydraulic hose 103 is fed through the same end of the main 94 as the cable 79 and is coupled to the fluid bore 71 in the mole head 52 by way of the hose coupling 72.

In the next stage, the liner 95 is clamped to the mole 51. Initially, the looped cable 97 is secured to the ring 96 and the cable 97 is then secured to the tensioning cable 98. The liner 95 is then pushed up the cylindrical portion 53 of the mole 51 until one end of the liner 95 engages with the ring 96. The clamping cup 99 is then slid along the tensioning cable 98 and the air hose 93 until the other end of the liner 95 is located within and engages with the cup 99. The tensioning cable 98 is then tensioned and locked by the locking device 100 and the liner 95 is therefore clamped compressively between the clamping cup 99 and the ring 96. As shown in Figures 8 and 10 the internal diameter of the liner 95 is greater than the internal diameter of the existing cast iron main 94.

The head portion 52 of the mole 51 is then insert-

ed into the cast iron main 103 until the cutting edges 60 of the blades 56, 57 and 58 engage the end of the main 103 as shown in the drawings. The pneumatic hammer 80 is actuated by supplying compressed air to its rear end by way of the air hose 93 so that the hammer 80 percussively drives the mole 51 through the main 94.

Simultaneously the mole 51 is drawn through the main 94 by the cable 79 which serves to guide the mole 51 axially through the main 94.

As the mole 51 moves through the main 103 the cutting edges 60 engage the internal wall of the main 94 and cause it to fracture. Since the cylindrical portion 53 of the mole 51 has a greater external diameter than the internal diameter of the main 94, the internal diameter of the fractured main 94 is widened out. The body 53 of the mole 51 also serves to provide clearance for the passage of the liner 95 therethrough and prevents debris from the fractured main and earth from falling into the pathway created for the liner 95.

Should the mole 51 encounter an obstruction in the main 94, such as a flange which narrows the internal diameter of the main 94, the movable blade 58 is pivoted outwardly to fracture the obstruction and provide a clearance for the liner. In this case hydraulic fluid is pumped to the piston 64 via the hose 103, duct 70 and the cylinder bore 65. The fluid pressure is relaxed immediately after the obstruction has been fractured so that the piston 64 relaxes and the blade 58 returns to its closed position. The hose 103 is of course moved simultaneously forward with the mole 51.

The liner 95 is pushed through and out of the main 94 after complete fracture thereof.

Finally, the mole 51, together with the associated locking device 100 is removed from the liner 95. The new main (not shown) may then be pushed manually or otherwise through the liner 95 which therefore forms a protective sleeve for the new main.

The new main may be of any convenient plastics material such as polyethylene or pvc while the liner is of a much tougher wear resistant plastics material.

Claims

1. A method for replacing or preparing for replacement a buried existing main with a new main, the method comprising dividing the buried main in situ to form discrete portions and moving the portions radially outwards to widen the bore of the main to form a passage having a diameter at least as great as the external diameter of the new main or a liner for the existing main, maintaining sufficient clearance through the passage for movement therethrough of a new main or a liner for the existing main, and moving the new main or liner endwise into the passage simultaneously with

the widening of the bore of the buried existing main, the liner to serve as a protective sleeve for the new main when the new main is subsequently moved into the liner, characterised in :-

(a) the division of the existing main being carried out so as to fracture the material thereof so that the discrete portions are in the form of debris of the kind which would fall unless prevented into the pathway formed for the new main or liner;

(b) causing a portion of the radially outward movement of the discrete portions to occur substantially simultaneously with the formation of the portions; and

(c) the debris and earth being prevented from falling into the pathway for the new main or liner.

2. A method as claimed in claim 1, characterised in that the buried main (8,94) is fractured and the passage is formed by a mole (1,51) which is moved through the buried main (8,94) and which has a portion (2,52) which both fractures the buried main (8,94) to produce debris and also causes the debris to be moved radially outwards substantially simultaneously with the formation of the debris.

3. A method as claimed in claim 2, characterised in that the portion is a tapering cylinder (2,52).

4. A method as claimed in claim 3, characterised in that the tapering cylinder (2,52) is frusto-conical.

5. A method as claimed in any of claims 2 to 4, characterised in that the portion (2,52) has at least one main fracturing member (7,56,57,58) adapted to engage and fracture the internal wall of the buried main (8,94).

6. A method as claimed in claim 5, characterised in that there are a plurality of such members (7,56,57,58).

7. A method as claimed in claim 6, characterised in that at least one of the members (58) is retractably movable outwards to engage and fracture and internal wall of the buried main (94).

8. A method as claimed in any of claims 2 to 7, characterised in that the mole (1,51) is driven through the buried main (8,94).

9. A method as claimed in claim 8, characterised in that the mole (1,51) is percussively driven through the buried main (8,94).

10. A method as claimed in claim 1, characterised in

that the buried main (45) is fractured and the passage is formed by a mole (21) which is moved through the buried main (45) and which has at least one retractably outwardly moving member (26) to engage and fracture the buried main (45) to produce debris and also cause the debris to be moved radially outwards substantially simultaneously with the formation of the debris.

11. A method as claimed in claim 10, characterised in that the mole has a plurality of such members (26).

12. A method as claimed in any of claims 2 to 11, characterised in that the new main (13,43) or the liner (14,44,95) is connected to the rear end of the mole (1,21,51).

13. A method as claimed in any of the preceding claims, characterised in that the internal diameter of the new main (13,43) is equal to or greater than the internal diameter of the buried main (8,45).

14. A method as claimed in any of the preceding claims, characterised in that the internal diameter of the new main (13,43) is equal to or greater than the external diameter of the buried main (8,45).

15. A method as claimed in any of the preceding claims, characterised in that the buried main (8,45,94) is of cast iron.

Patentansprüche

1. Verfahren für den Austausch oder die Vorbereitung des Austausches einer bestehenden Unterflurleitung gegen eine neue Leitung, mit den Verfahrensschritten des Aufteilens der Unterflurleitung an Ort und Stelle zur Bildung von Einzelteilstücken und des Bewegens der Einzelteilstücke radial auswärts, um die Bohrung der Leitung aufzuweiten und dadurch eine Passage zu bilden, deren Durchmesser mindestens so groß wie der Außendurchmesser der neuen Leitung oder einer Auskleidung für die bestehende Leitung ist, des Aufrechterhaltens eines ausreichenden Spiels durch die Passage hindurch zum Bewegen einer neuen Leitung oder Auskleidung für die bestehende Leitung durch die Passage hindurch und des Bewegens der neuen Leitung oder Auskleidung axial in die Passage gleichzeitig mit dem Aufweiten der Bohrung der bestehenden Unterflurleitung, wobei die Auskleidung als Schutzhülle für die neue Leitung dient, wenn diese nachfolgend in die Auskleidung bewegt wird, gekennzeichnet

zeichnet durch folgende Verfahrensschritte:

- (a) die Aufteilung der bestehenden Leitung wird so ausgeführt, daß das Material derselben aufgerissen wird, derart, daß die Einzelteilstücke die Form von solchen Trümmerstücken haben, die, wenn nicht daran gehindert, in den für die neue Leitung oder Auskleidung gebildeten Bewegungsweg fallen würden; 5
 - (b) ein Teilstück der radialen Auswärtsbewegung der Einzelteilstücke erfolgt im wesentlichen gleichzeitig mit der Bildung der Teilstücke; und 10
 - (c) die Trümmerstücke und Erde werden daran gehindert, in den Bewegungsweg der neuen Leitung oder Auskleidung zu fallen. 15
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Unterflurleitung (8, 94) aufgerissen und die Passage durch eine Mole (1, 51) 20 gebildet wird, die durch die Unterflurleitung (8, 94) hindurchbewegt wird und ein Teilstück (2, 52) aufweist, das sowohl die Unterflurleitung (8, 94) aufreißt, um Trümmerstücke zu erzeugen, als auch die Trümmerstücke veranlaßt, sich im wesentlichen gleichzeitig mit ihrer Bildung radial nach außen zu bewegen. 25
 3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß das Teilstück ein zugespitzter Zylinder (2, 52) ist. 30
 4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß der zugespitzte Zylinder (2, 52) kegelförmig ausgebildet ist. 35
 5. Verfahren nach einem der Ansprüche 2 bis 4, dadurch gekennzeichnet, daß das Teilstück (2, 52) zumindest einen Hauptaufreißbauteil (7, 56, 57, 58) aufweist, der mit der Innenwand der Unterflurleitung (8, 84) in Wirkverbindung steht und diese aufreißt. 40
 6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, daß eine Vielzahl solcher Bauteile (7, 56, 57, 58) vorgesehen ist. 45
 7. Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß zumindest einer der Bauteile (58) rückstellbar nach außen bewegbar ist, um mit der Innenwand der Unterflurleitung (94) in Wirkverbindung gebracht zu werden und diese aufzubrechen. 50
 8. Verfahren nach einem der Ansprüche 2 bis 7, dadurch gekennzeichnet, daß die Mole (1, 51) durch die Unterflurleitung (8, 94) hindurchgetrieben wird. 55

9. Verfahren nach Anspruch 8, dadurch gekennzeichnet, daß die Mole (1, 51) stoßend oder schlagend durch die Unterflurleitung (8, 94) hindurchgetrieben wird.
10. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Unterflurleitung (45) aufgerissen und die Passage durch eine Mole (21) gebildet wird, die durch die Unterflurleitung (45) hindurchbewegt wird und zumindest einen rückstellbar nach außen bewegbaren Bauteil (26) aufweist, der durch Einwirken auf die Unterflurleitung (45) diese aufreißt, um Trümmerstücke zu erzeugen und diese außerdem im wesentlichen gleichzeitig mit ihrer Entstehung radial nach außen zu bewegen.
11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Mole eine Vielzahl solcher Bauteile (26) aufweist.
12. Verfahren nach einem der Ansprüche 2 bis 11, dadurch gekennzeichnet, daß die neue Leitung (13, 43) oder Auskleidung (14, 44, 95) mit dem hinteren Ende der Mole (1, 21, 51) verbunden ist.
13. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Innendurchmesser der neuen Leitung (13, 43) gleich dem oder größer als der Innendurchmesser der Unterflurleitung (8, 45) ist.
14. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Innendurchmesser der neuen Leitung (13, 43) gleich dem oder größer als der Außendurchmesser der Unterflurleitung (8, 45) ist.
15. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Unterflurleitung (8, 45, 94) aus Gußeisen besteht.

Revendications

1. Procédé pour remplacer ou préparer le remplacement d'une canalisation enterrée existante par une nouvelle canalisation, le procédé consistant à éclater sur place la canalisation enterrée pour former des morceaux physiquement distincts et à déplacer les morceaux radialement vers l'extérieur pour élargir la lumière de la canalisation afin de former un passage ayant un diamètre au moins aussi grand que le diamètre extérieur de la nouvelle canalisation ou d'une chemise pour la canalisation existante, à maintenir un dégagement suffisant dans le passage pour permettre un mouvement dans celui-ci d'une nouvelle cana-

lisation ou d'une chemise pour la canalisation existante, et à introduire en bout la nouvelle canalisation ou la chemise dans le passage en même temps que la lumière de la canalisation enterrée existante et élargie, la chemise étant destinée à servir de gaine protectrice pour la nouvelle canalisation lorsque celle-ci est ensuite introduite dans la chemise, caractérisé en ce que :

- a) l'éclatement de la canalisation existante est effectué de façon à fracturer sa matière pour que les morceaux physiquement distincts se présentent sous la forme de débris de la forme qui tomberaient, s'ils n'en étaient empêchés, dans le trajet formé pour la nouvelle canalisation ou la chemise ;
- b) une partie du mouvement radial vers l'extérieur des morceaux physiquement distincts est amenée à se produire à peu près simultanément à la formation des morceaux ; et
- c) on empêche les débris et la terre de tomber dans le trajet pour la nouvelle canalisation ou la chemise.

2. Procédé selon la revendication 1, caractérisé en ce que la canalisation enterrée (8,94) est fracturée et le passage est formé par une taupe (1,51) qui est déplacée dans la canalisation enterrée (8,94) et qui comporte une partie (2,52) qui à la fois fracture la canalisation enterrée (8,94) pour produire des débris et amène aussi les débris à être déplacés radialement vers l'extérieur à peu près simultanément à leur formation.

3. Procédé selon la revendication 2, caractérisé en ce que la partie est un cylindre effilé (2,52).

4. Procédé selon la revendication 3, caractérisé en ce que le cylindre effilé (2,52) est tronconique.

5. Procédé selon l'une quelconque des revendications 2 à 4, caractérisé en ce que la partie (2,52) comporte au moins un élément (7,56, 57, 58) de fracturation de canalisation conçu pour porter contre la paroi intérieure de la canalisation enterrée (8,94) et pour la fracturer.

6. Procédé selon la revendication 5, caractérisé en ce qu'il y a plusieurs de ces éléments (7,56, 57, 58).

7. Procédé selon la revendication 6, caractérisé en ce qu'au moins l'un des éléments (58) peut être déplacé de façon rétractable vers l'extérieur pour porter contre la paroi interne de la canalisation enterrée (94) et la fracturer

8. Procédé selon l'une quelconque des revendications 2 à 7, caractérisé en ce que la taupe (1,51)

est entraînée dans la canalisation enterrée (8,94).

9. Procédé selon la revendication 8, caractérisé en ce que la taupe (1,51) est entraînée par percussion dans la canalisation enterrée (8,94).

10. Procédé selon la revendication 2, caractérisé en ce que la canalisation enterrée (45) est fracturée et le passage est formé par une taupe (21) qui est déplacée dans la canalisation enterrée (45) et qui comporte au moins un élément (26) mobile de façon rétractable vers l'extérieur pour porter contre la canalisation enterrée (45) et la fracturer afin de produire des débris et pour aussi amener les débris à être déplacés radialement vers l'extérieur à peu près simultanément à leur formation.

11. Procédé selon la revendication 10, caractérisé en ce que la taupe comporte plusieurs de ces éléments (26).

12. Procédé selon l'une quelconque des revendications 2 à 11, caractérisé en ce que la nouvelle canalisation (13,43) ou la chemise (14, 44, 95) est reliée à l'extrémité arrière de la taupe (1, 21, 51).

13. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre intérieur de la nouvelle canalisation (13, 43) est égal ou supérieur au diamètre intérieur de la canalisation enterrée (8,45).

14. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que le diamètre intérieur de la nouvelle canalisation (13, 43) est égal ou supérieur au diamètre extérieur de la canalisation enterrée (8,45).

15. Procédé selon l'une quelconque des revendications précédentes, caractérisé en ce que la canalisation enterrée (8,45, 94) est en fonte.

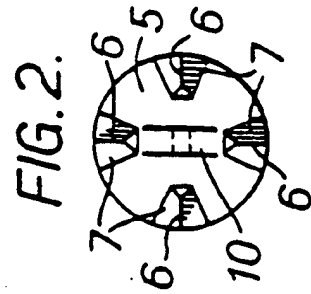
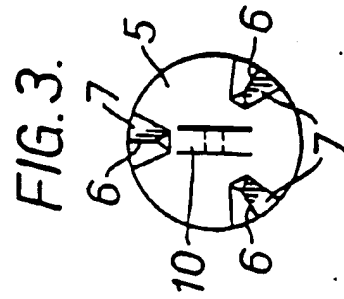
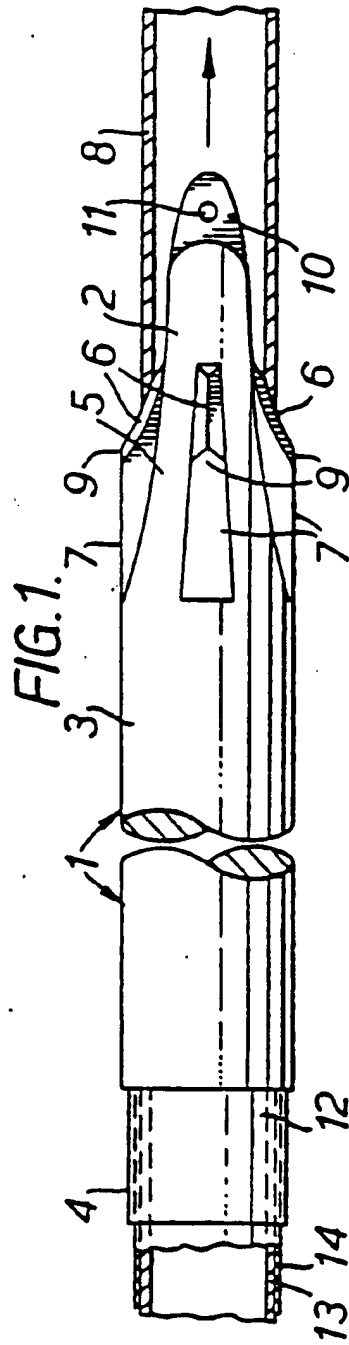


FIG. 4.

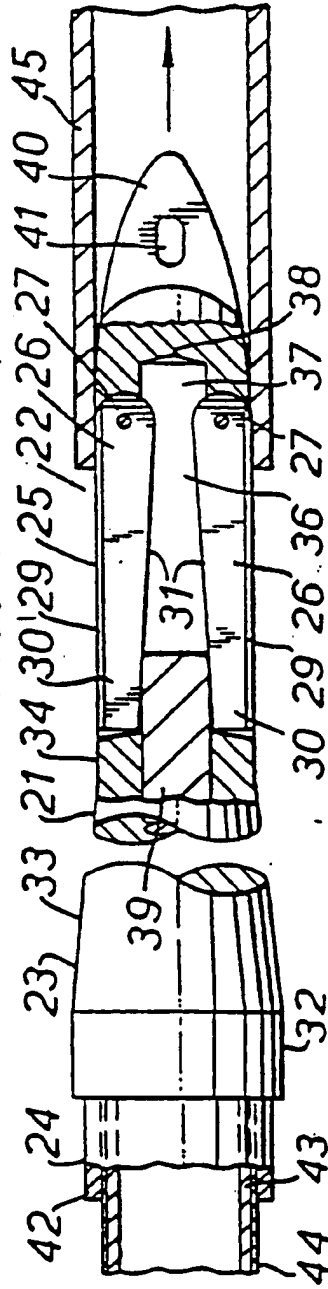


FIG. 5.

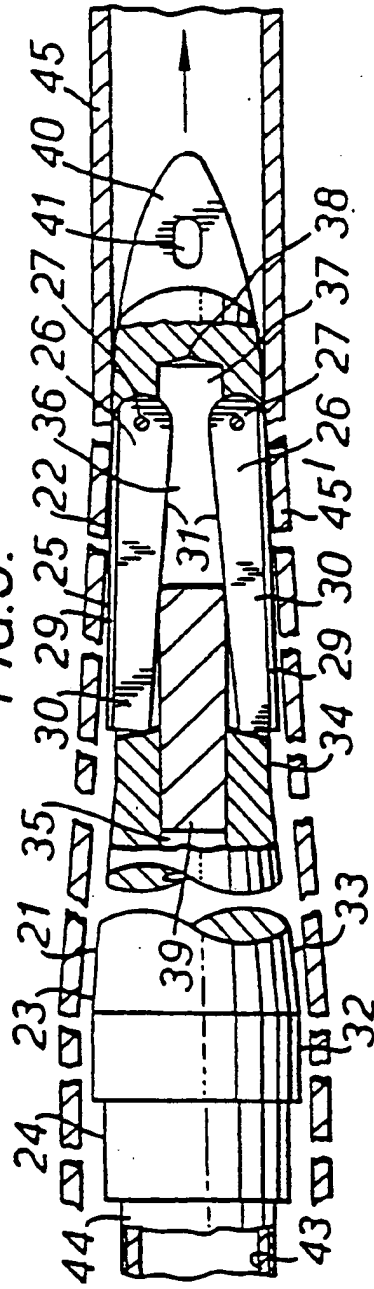


FIG. 6.

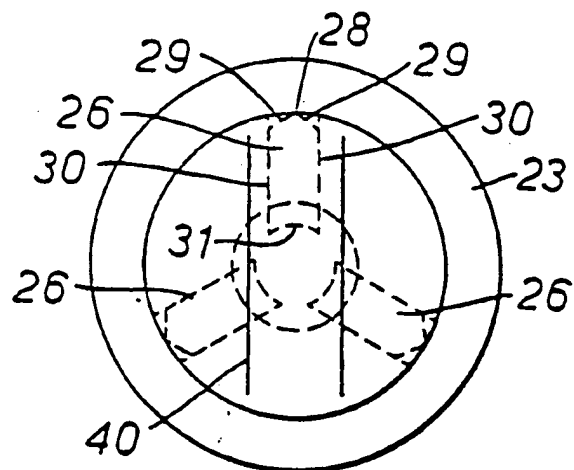
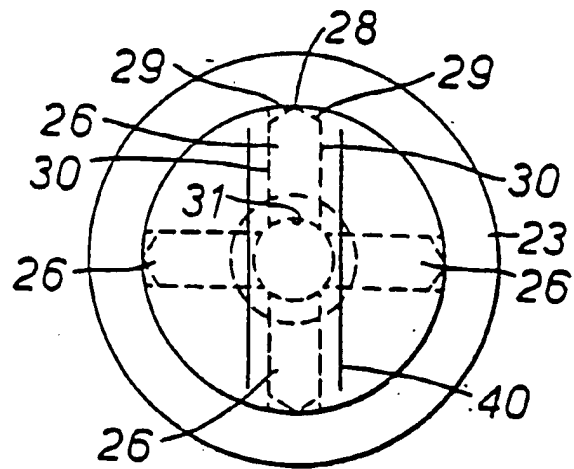


FIG. 7.



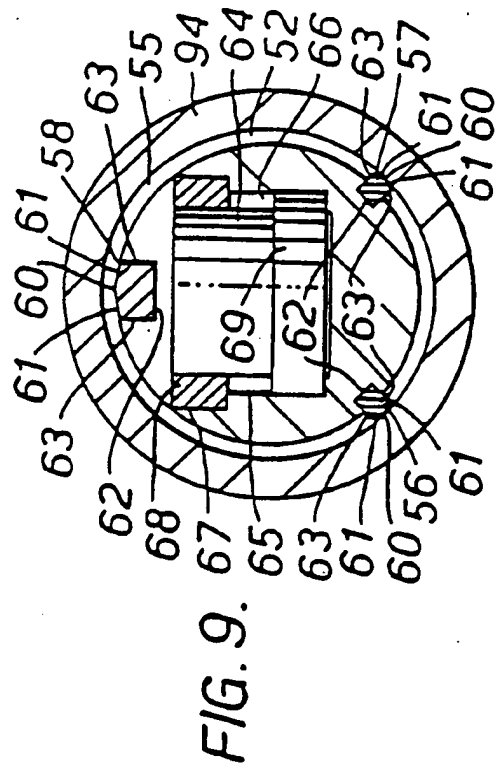
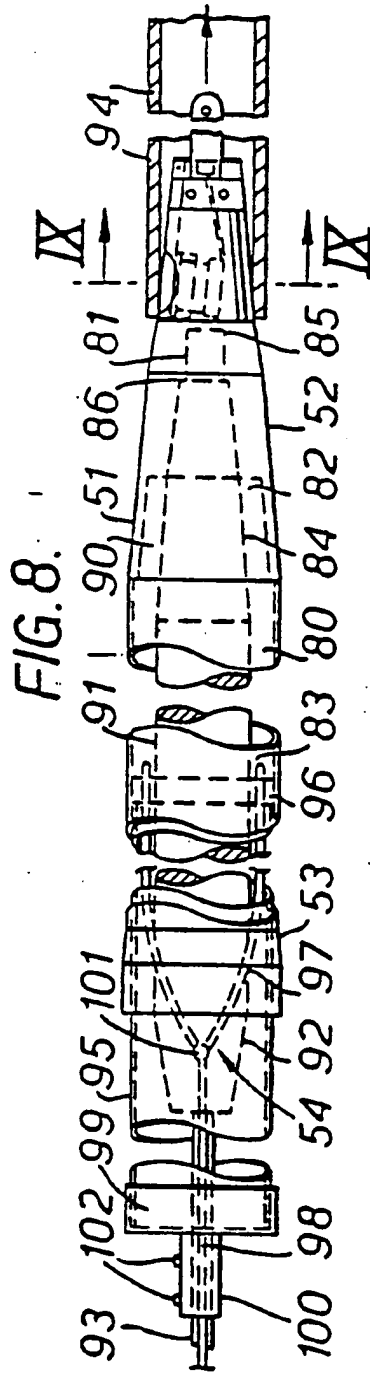


FIG.10.

